

The Russians in the Arctic

ASPECTS OF SOVIET EXPLORATION AND
EXPLOITATION OF THE FAR NORTH

by

TERENCE ARMSTRONG

1914

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Preface

My friend Bertrand Imbert, an experienced Antarctic traveller, and leader of the French International Geophysical Year expeditions to the Antarctic, gave me the stimulus to write this book. It was to have been our joint production, but his Antarctic work was too demanding of his time. Had the original plan been realized, it would have been a better book. But there are many traces of his influence in the present one, and I know they are improvements.

The substance of chapters four and five has been published in the *Polar Record* and the *Geographical Journal*, and I would like to thank their editors for kind permission to use the material here. I must also acknowledge with gratitude my debt to the Scott Polar Research Institute, where I found shelter, encouragement, and virtually all the source materials.

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The maps were drawn by K. C. Jordan.

Introduction

The polar regions comprise about one seventh of the total land surface of the globe. The world population is increasing by over 30 millions every year, so that the pressure of man on his environment is rising sharply: pressure on food resources, on all other raw materials, on living space. During the last 200 years Europeans have opened up hundreds of thousands of square miles for development in many parts of the world. But there are only a few undeveloped regions left, and the chief of them are those about the Poles. The polar regions, then, cannot fail to become more important. And of the two regions, the Arctic is bound to play the greater part because its two major land-masses are not isolated, almost entirely covered in ice, and uninhabited, like Antarctica, but are merely the Arctic extensions of the two most populous continents. The growing importance of the Arctic is already, of course, plainly apparent: the trans-polar air routes, the northward movement of mining in North America and of fishing in the North Atlantic, the network of weather stations, to mention only some aspects which are not primarily strategic.

If the Arctic is the place to watch in the polar regions, the Soviet Union is the place to watch in the Arctic. To begin with, it occupies nearly half the total area of the Arctic, in the sense that the Circle runs through Soviet territory for 164 degrees out of 360. Secondly, if one looks at the distribution of population in the northern hemisphere north of, say, the 55th parallel, one can see at once that Canada, Alaska, and Greenland are very thinly inhabited indeed, while northern Eurasia has major population centres in the north – Moscow, Leningrad, the Ural industrial region, and the Scandinavian capitals. In terms of population, the preponderance of the old world over the new to the north of this limit is of the order of 500 to one. This preponderance is still great if one adjusts the line to conform more

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nearly to the southern boundary of the Arctic and sub-Arctic. There are all sorts of different definitions of this boundary, depending on which polar phenomena one is interested in; there is no need to go into them, but all agree that it does not follow the Arctic Circle or any other parallel of latitude; it curves irregularly, and roughly speaking only the northernmost part of Scandinavia should be included, while in Siberia the line bends far south of the Circle to reach even into Mongolia in places. So it is in the Soviet Union that one finds by far the greatest number of people who know what the Arctic is like. What is more, they have known it for a long time; for the settled areas of Siberia are not only much more numerous but also older established than their North American counterparts.

For geographical and historical reasons, then, one would expect the Soviet Union to lead the world in knowledge of the Arctic and experience in solving the problems it raises. The purpose of this book is to show to what extent this has been true during the period when the attention of the world has been focused more closely on the Arctic, that is to say, over the last twenty years or so. If it were any other country but the Soviet Union there would be little need to do this, because her achievements would already be common knowledge. But the Soviet Union has erected barriers which have hidden, and still do hide, a large proportion of what she does in the north. Of the magnitude of the effort put into it there can be no doubt. I recently visited the Arctic Institute in Leningrad. This efficient and hard-working institution employs 500 people in the handsome eighteenth-century palace in which it has its headquarters – and this is at least five times as many as the comparable organizations in Cambridge, Oslo, Copenhagen, Paris, Montreal, New York, and Washington put together. The contrast may be lessened by Soviet prodigality of man-power and by different organizational methods in the Western countries, but even so it remains remarkable, and it is an indication of the proportionate effort.

It is not yet possible to provide even a moderately complete picture of that effort. But enough has filtered through to give a general idea. This book is a collection of accounts of events in

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the Soviet Arctic since about 1937. The selection is haphazard, being dictated by what has been published in the Soviet Union. A few of the happenings reached the English press in one form or another, but most have received no publicity outside the Soviet Union and often little inside it.

Some chapters are directly concerned with geographical exploration: the drift of the *Sedov*, the Pole of Inaccessibility expedition, the high-latitude air expeditions. From these one can get some idea of the scope and general background of Soviet work in the Arctic: the way they go about it, their competence, their attitude of mind. The chapter on the voyage of the German raider *Komet* shows not exploration, but exploitation: a particular example, not without interesting sidelights on other matters, of how the work of twenty years could be put to use. In the chapter on the Northern Sea Route the theme of exploitation is developed, and it is possible to begin to estimate what sort of return the Russians are getting for their very great capital investment. There is material available for some assessment of quite another aspect of the Soviet advance into the Arctic: the impact of Soviet rule on the primitive native tribes of the north Siberian wilderness. This has interest not only from the point of view of Soviet Arctic achievement, but as being a subject in which communist doctrine is involved. And finally there is something on certain scientific investigations of a somewhat more specialist character than those which are carried out by the big expeditions of the sort mentioned in earlier chapters: the archaeological finds on the peninsula of Taymyr, and study of a mammoth corpse.

Taken together, these largely fortuitously collected pieces do throw some light on the main outlines of Soviet Arctic endeavour. And with this background, it may be easier to understand why the Russians contributed more Arctic stations in the International Geophysical Year of 1957-58 than any other country, and why they were able to mount a very large and complex Antarctic expedition with virtually no experience at all of Antarctic work; and to form some opinion of the importance and value of the results they have obtained.

CHAPTER ONE

The Drift of the *Sedov*

In the middle of June 1937 a rather insignificant-looking ship slipped away from the quay at Arkhangel'sk. She was not very large, and although she was generally called an ice-breaker, she was not very powerful either. Her name was the *Georgiy Sedov*, 3,056 tons displacement and 2,400 h.p. She was off to the Arctic again – she had been there many times before – to carry out a programme of scientific work and to use such icebreaking ability as she had in giving help wherever it might be needed. It was likely to be an interesting, perhaps exciting, but nevertheless routine voyage, very like the voyages she had made in earlier summers, and like those made by three or four ships of the same type each year. Not a man on board, or ashore either, for that matter, could have foretold that the *Sedov* was starting out on one of the most important Arctic voyages of recent times, or that it would be more than two and a half years before she saw her home port again. For the curious thing about the drift of the *Sedov* is that it began as a dreadful mistake.

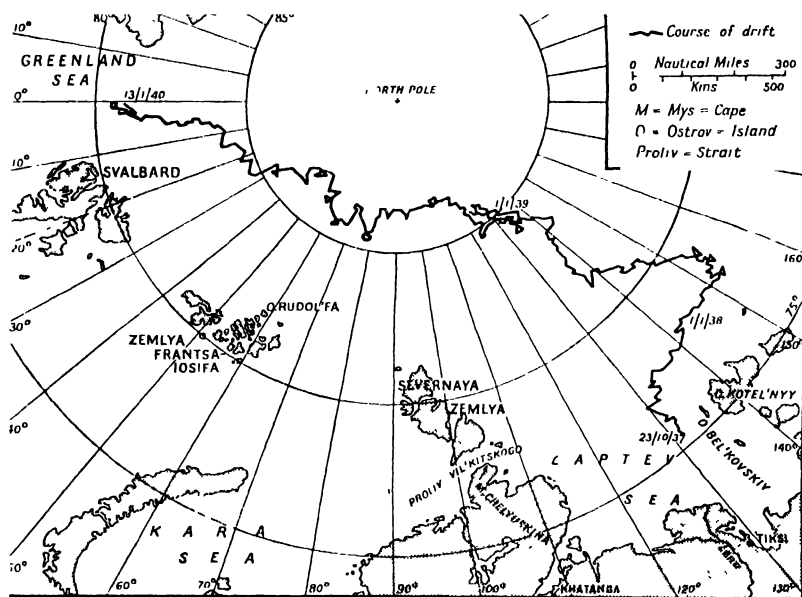
That summer the shipping routes north of Siberia were going to be busy. While freighters did the fetching and carrying, ships like the *Sedov* were to do the more difficult jobs that necessitated leaving the shipping lanes along the coast. Accordingly, she called at weather stations on remote islands, and carried out her scientific programme en route. It was a busy voyage, and September found her in the Laptev Sea, roughly midway between the Atlantic and the Pacific, when orders came to return home.

The situation was none too easy. A number of ships were in the area, and there was a shortage of coal for bunkers at Tiksi,

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the port by the mouth of the Lena river. In addition, the ice situation was serious; the forecasts had proved wrong, and there was a mass of ice still blocking Proliv Vil'kitskogo, the strait between Severnaya Zemlya and the mainland, lying directly on the route back to Arkhangel'sk.

On 24 September new ice was beginning to form in sheltered bays. The fuel was shared out, but no ship had enough to battle with the ice and get home as well; nevertheless they all set out.



Map 1. The drift of the *Sedov*, 1937-40.

Everyone hoped, of course, to go eastwards; if the way to the west was blocked, why not try to reach Bering Strait and Vladivostok? But the *Sadko* and the *Malygin*, two ships similar to the *Sedov*, were ordered westwards, to help the more powerful ice-breakers *Lenin* and *Krasin* assist ships struggling towards the strait. The *Sedov* tried to help some ships in difficulties, damaged her propeller and got stuck herself. The *Sadko*, sent to the rescue, came up with her about 200 sea miles short of the entrance to Proliv Vil'kitskogo. The *Sadko* being the more powerful ship, the *Sedov* was soon freed; but it was then found that

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the way westwards was blocked by ice too difficult for either ship. Any attempt to reach the *Lenin* was no longer possible. At last it was decided that the *Sadko* and the *Sedov*, together with the *Malygin*, which had just joined them with more coal, should head for Vladivostok.

But it was already 15 October, and the decision had come too late. The new ice was nearly a foot thick, and the three ships could make only a few miles each day. Hopes were raised three days later, for it was the full moon, and the bigger tide could be expected to make the ice move. This did happen, and a record run of sixty-eight miles was the result. Another two or three days like this, and the worst would probably be over. But there was never a chance to find out. On the 21st nine-tenths ice was met; the ships forced their way forward ten miles, but during the day the wind and current drove the ice, and the ships in it, the same distance back again. For two more days the effort was kept up; but on the 23rd the prospect of reaching open water was recognized as hopeless. The ships stopped their engines and lay drifting. For the 217 people on board the possibility of wintering at sea, already discussed anxiously over the past month, became a certainty.

The trio of ships were now thirty-seven sea miles west of the small island called Ostrov Bel'kovskiy – where, incidentally, there was open water – and some 250 sea miles from the Siberian mainland. The situation facing them was not reassuring. They were certain to drift during the winter, and previous experience showed that it would be northwards. Everyone realized this. But how far would the ships go? By the time the next summer arrived, and with it the possibility of relief, would they be too far north to be within reach? The prevailing mood, it may well be imagined, was not one of optimism.

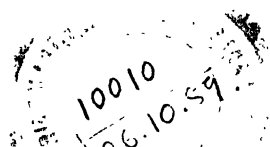
But there was little time at first for reflection, gloomy or otherwise. The ships had to be got ready for wintering. First of all, could anything be done about their actual position in the ice? The ice surrounding them would not stay in one vast piece all the winter. Various stresses and strains, induced by wind or current, would break it up, and huge floes would cannon into

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each other, slowly but with prodigious momentum, causing great pressure along the line of contact. For the ships, a great deal depended on their position in relation to the lines along which pressure was likely to develop. The *Chelyuskin* was crushed in 1934 because she was lying in an old 'lead', or narrow channel in the ice, and could not get out of it; it was much the same with De Long's *Jeannette*. So Captain Khromtsov of the *Sadko* manœuvred his ship – local movement was still possible – into a lagoon in the middle of a floe of old ice. This turned out to be an excellent choice. The old, heavy ice prevented the waves of pressure reaching the ship at all. The *Malygin* laid up at the edge of a piece of thick ice. This was a dangerous position, as became clear when ice piled up against the ship from the other side until it was level with the deck. Fortunately the *Malygin* had not yet taken her engine out of commission for the winter, so she was able to move along a little way to a safer place. The *Sedov* was the worst off. She lay between two large floes, which were apt to move together and nip the ship. She could not move away from this place, and as a result was caught in severe pressure twenty times during the winter.

A good deal of reorganization of men and stores was undertaken. These 217 souls – some women among them – were not just the crews of the three ships. There were two scientific expeditions, and a number of people on their way home, as they hoped, after a year or more at a polar station. There were also a good many students from the Hydrographic Institute (a training-school for Arctic chartmakers) doing the practical part of their course. These students all went to live in the *Sedov*. The scientists concentrated in the *Sadko*, which had the best facilities for laboratory work. And the polar-station people were transferred to the *Malygin*. Each crew remained in its own vessel.

There were one or two people who should not really have been on board at all. One was the captain of a ship who had finished his job at Tiksi, but had got himself a passage home in the *Sadko* because he thought it would be quicker than the over-



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land route. And then there were the carpenters who had no connexion with the Arctic at all, but had come along to build a new hut at a polar station. These had to fit into the scheme somewhere and make themselves useful.

The total quantities of stores for all the ships were totted up. The *Sedov* had been badly equipped; she had not got enough food or winter clothing for the people on board her, so both were supplied by the other ships. There was a general shortage of coal and paraffin. The boilers were kept in until 7 November – the anniversary of the Revolution of 1917 – so that there would be light and warmth for the festivities. Thereafter stoves provided the heat – if it could be called heat; for besides the fuel shortage, the system used was not efficient, and if the living quarters reached a temperature of 40° or 50° F. it was considered good. Rooms with wooden panelling were chosen for living in, because the wood kept in the warmth better than metal. Paraffin lamps provided the light. After the steam heating and electric light there was a general impression of darkness, stuffiness, dirtiness, and coldness. Emergency stores – three months supplies of food and camping equipment – were brought up on deck and kept ready to be taken out on to the ice if danger threatened the ship.

Scientific work continued all winter. It was quickly evident that some observations would be of very special interest; for the ships started following, remarkably closely, the track of the only other ship which had ever been in these parts. This was the *Fram* of Fridtjof Nansen, the greatest of all polar explorers. He had conceived the idea of drifting across the Arctic Ocean in a ship designed specially to withstand ice pressure. Everyone thought the idea was suicidal, but Nansen went ahead just the same. For three years the world heard nothing from the thirteen men aboard the *Fram*, but in 1896 they all returned; everything had gone just as Nansen imagined it would. So now, forty-four years later, the chance of comparing all sorts of biological and oceanographical phenomena with what had been observed before in the same extremely remote region was one that could on no account be missed. The members of the *Sadko*

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expedition were just the people to be doing this; for they had spent the season in high latitudes and knew what to look for.

The interest in comparative observations grew still greater when it became clear that there would be a comparison not only with the same place at a different time, but the same time at a different place. The men in the *Sadko* of course knew all about Papanin's party, drifting several thousand miles away between the North Pole and Greenland. But it was interesting to hear that on November 14 another, and much closer drift had started. The *Lenin* and her convoy of four merchantmen were wintering also in the Laptev Sea, near the mouth of the Khatanga river, and on that day a strong south-westerly wind detached from the shore the ice in which they were fast. For nine months the two groups were drifting simultaneously in opposite corners of the same sea.

A strict routine for making observations was quickly established. A meteorological station was set up in the *Malygin*, and hourly observations were made. Every two hours a sounding was taken and the speed and direction of drift measured. The position was fixed more accurately by astronomical determinations, made whenever visibility allowed. Regular measurements were made of the elements of terrestrial magnetism and of the force of gravity. Every thirty miles of drift a hydrological station was worked; this meant that samples of water from various depths were brought up and analysed, the living organisms in them were studied, and bottom samples were taken for geological investigation.

Since the scientists, among whom were some senior men in various fields, were living next door to the students, a sort of University department developed. Lecturers went across from the *Sadko* to the *Sedov*, sometimes – such was the respect they commanded – escorted by seamen, in case of a chance meeting with a polar bear on the way to the lecture-room. The students busily took notes; but in the smallest possible handwriting, because paper was one of the commodities in shortest supply.

This example of dutiful application to the task of improving the mind was quickly followed. The seamen, not to be outdone,

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arranged courses for helmsmen and engine-room artificers. The future captain of the *Sedov*, Konstantin Sergeyevich Badigin, now second officer in the *Sadko*, was put in charge of a school of 'political literacy', where he lectured on socialism and communism in the Soviet Union, and on the significance of the Paris Commune; but it was when the discussion turned to agriculture and collectivization that the audience's reactions were liveliest. Most of them knew a good deal about that at first hand, and had vivid memories of recent upheavals in country districts.

The daily routine was from time to time interrupted by national festivals and holidays, all of which were punctiliously observed. They were almost all of a political nature, but this did not detract from their value as morale-raisers. There was, for instance, the day of the elections to the Supreme Soviet. Great fun was evidently had by all. The ships formed part of an Arkhangel'sk constituency, and all directions as to procedure were radioed from there: the line to be taken by agitators at election meetings, the method of voting, even the correct size of ballot paper (they had to be home-made, of course). Stalin's election speech was heard by everyone, even though it came over the air in the small hours. And everyone, it seems, was deeply moved as the soft, unemotional voice repeated platitudes to the accompaniment of thunderous ovations from the Moscow audience. When the day itself arrived, everyone put on their best clothes, some even shaved, and the electric-light system was specially re-activated for the occasion. Voting was followed by a concert which lasted well into the night, and for which a climax was provided by announcement of the result: 100 per cent of the electorate voted, and 100 per cent of votes cast were for the communist candidates. The fact that no other candidates were standing was in no way reflected in the wild applause.

There were continuous attempts to raise the standard of living. This was difficult, undoubtedly, because the only resources available were very limited and everyone knew what they were. First came the wind-power generator experiments. Several 'firms' tried to produce a windmill to work the lighting system.

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Instructions were asked for over the radio and obtained, but they generally involved use of parts or materials which were not to be had. In the end one machine which worked after a fashion was built, but it could not solve the gust problem; when the wind was slight the lights were very dim, and when it was strong the lights burnt themselves out. So all it could be used for was charging accumulators for the radio transmitter.

The windmill craze was succeeded by a more rewarding one. Someone found some old traps in one of the holds, and a day or two later the members of the first hunting combine had a fine arctic fox pelt to show for their idea. In no time hunting became the rage. It involved much effort on the part of its devotees, for it had to be done 'out of hours'. The only concession to hunters was permission to miss physical training, which took place before breakfast each morning. It was rightly supposed that hunting was a good deal more strenuous than p.t. anyway. The number of traps and, no doubt, the lack of finesse in allaying the suspicions of the quarry soon led to the disappearance of arctic fox from the vicinity of the ships. But the hunting season had served its turn.

Nature, one need hardly say, provided another source of the unexpected and therefore of the interesting. But its manifestations were not very often pleasant. Occasional loud reports, or rolls as of thunder would be heard. These were made by movement of the ice. Some idea of the power behind a slowly drifting mass of ice can be imagined when one considers that a floe two yards thick and a mile square – quite a normal size – weighs about 8 million tons; and the total area of ice moving in the same direction is always vastly bigger than a square mile. If a force of this order meets resistance, the pressure put on the resisting object – ship, land, or more ice – is enormous. Out here, far from land, it was mostly ice meeting ice. When this happened blocks of ice would break off and pile up to form a 'pressure ridge' along the line of contact. These ridges were often twenty feet or more high. The rumbles that were heard were generally made by this sort of action. The sight and sound of a pressure ridge forming in the starlit darkness of the winter

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months must have been awe-inspiring. Add to it the feeling that the ship might have been in the direct line of pressure, and it must have become terrifying. The crew of the *Sedov* were constantly having to go to emergency stations, while desperate attempts were made to alter the direction of the line of pressure by letting off well-placed explosive charges in the ice.

New Year's Eve provided the most frightening example of all. Aboard the *Sadko* there was a party in progress. It was a great event, for two of the girl scientists had manufactured a New Year tree out of an old oar, broom twigs, marine biological specimens, and other unlikely objects. But the fun was suddenly interrupted by an alarm from the *Sedov*. A particularly powerful wave of pressure was approaching, and the ship was directly in line.

'There was a tremendous rumble over the sea,' writes an eyewitness. 'Large floes cracked with a roar, the pieces twisted and crawled over each other, squeaking and hissing. At times there was a rattle like machine-gun fire. Then it was more like long-range artillery. And suddenly in the succeeding silence one heard again the soft whistle of ice slabs climbing up on one another.' It seemed as if the *Sedov* was lost. Another two yards advance by the relentlessly oncoming floe and her hull would be nothing but a heap of twisted iron. But at that very moment the pressure slackened. Nobody slept that night, for fear it would start again. And the next day it did, and the day after. But once again, partly by good luck and partly by skilful blasting, the ship escaped serious damage; one of the ship's boats, lying on the ice as part of the emergency stores, was crushed to matchwood. There were six more periods of pressure in January, but the New Year excitements were the worst.

As soon as daylight began to reappear, at the beginning of February, everyone's thoughts turned to the possibility of relief. It had been known all the winter that an air expedition was to be sent out in the spring to take off everyone not essential to the working of the ships; and at the end of January the word was received that at the Moscow end preparations were well advanced. The first essential was to prepare an aerodrome.

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Nobody on the ice had much idea how this was to be done. There was no flyer among them, so there was no expert opinion. Some could remember that the pilots who had taken Papanin's party to the North Pole in 1937 had said there were plenty of large, flat floes up there, any of them just as good for landing on as the one they in fact chose. There was no need of an expert to see that things were entirely different in the north part of the Laptev Sea; here there was no floe smooth and large enough to land on anywhere in sight. The landing-strip had to be near the ships because there were sick people, and even one expectant mother, who had to be flown out. Furthermore, there had to be several, in case one should be damaged by pressure.

Parties set out to reconnoitre. After several days one suitable area was found, and only a mile away. By removing some hummocks a strip 1,000 yards long and 1,000 yards wide could be made. These were the dimensions laid down in the instructions from Moscow. Some days later another good site was found; nearly as big as the first one without removing anything, but two and a half miles away. Work was started at both places; four teams of ten men from the *Sadko* at No. 1, and eight teams from the *Sedov* and *Malygin* at No. 2. The clearance work was very strenuous. Every morning if there was fog – indicating patches of open water – in the direction of the air strips, everyone's heart sank for fear there should be a great crack across the middle of one of them. But luckily this did not happen. By the end of February No. 2 strip was ready; 1,324 man-days and over a ton of ammonal in 890 separate explosions had been expended in getting it into shape. The working teams were transferred to No. 1 to help the *Sadko* men. Word was received at the same time that the aircraft had left Moscow on the first stage of their flight.

On the very next day, 1 March, the commandant of No. 2 strip ran, white-faced, to the ships.

'It's cracked,' he said.

Horror and frustration filled the colony. A large corner of the strip had been broken up into hundreds of pieces. There

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was no way of 'mending' it. The only outlet for people's feelings was to work even harder on strip No. 1. Five days later it was ready for use. And that very night, as if the elements had been waiting to choose the most disheartening moment, the ice moved again. No. 2 strip was finally wrecked – a network of cracks now crossed it in all directions, and quite a large lake appeared at one end of it. No. 1 had a crack right across, with a ridge beside it fifteen feet high and ninety feet wide. Still more discouraged, the men set about removing this ridge, and scouts were sent out to find a third site.

Meanwhile on 21 March the radio announced that the aircraft had reached Tiksi, the base from which they would fly to the ships. The flight would be made as soon as the weather permitted.

As the time grew shorter, everyone got more and more anxious about possible last-minute damage to the strips. No. 3 was long enough but too narrow, and a great deal of ice still had to be moved. In order to lessen the risk of cracking, as little explosive as possible was used and the ice was laboriously taken away by hand. On 25 March the job was reported finished. No. 1 was in reserve, but not really usable without more work. So all hands were directed there, and a few days' hard work produced a difficult, but possible, landing-strip. After all, people thought, it will probably not be necessary to use No. 1 at all.

The morning of 3 April was still and cloudless. Tiksi also reported better weather, and expectancy mounted. The commandant of No. 3 strip paid an early visit to his site to make a final check. By 6 a.m. he was back at the ships. The worst had happened: there were cracks all over the strip. A quick decision had to be made: should the aircraft be put off until a fourth site was got ready, or should everything be staked on the not very satisfactory reserve, No. 1? The weather was a vital point. If this spell of excellent flying weather were not used it might be a question of waiting for weeks. So it was decided to use No. 1, and to spend what little time was left getting it in better order.

How little time there was became quickly clear. A message

said that the aircraft had left Tiksi at 8.44 that morning. This meant they could be expected in six hours. Furthermore, the first hundred of those due for evacuation had to be ready to leave. There was frenzied activity that morning. Then, soon after half-past two, the three aircraft came in sight. They were the same ANT-6 machines, specially modified for long-range Arctic flying, which had taken Papanin's party to the Pole the year before. They circled the ships, had a good look at the landing-strip, and came in to land. The construction gangs watched anxiously, as their two months of back-breaking and frustrating work was put to the test. The leading aircraft touched down on an unnoticed bump in the ice surface and bounced into the air again; then she steadied, and landed smoothly. The other two came down without any incident. Crowds collected round them as soon as they stopped, and post-bags were opened on the spot and distributed to the excited winterers.

The constructors, however, had hard words thrown at them. The strip was not good enough. The bump in the ice had damaged the first aircraft's ski undercarriage. As a result take-off was likely to be difficult, so no passengers could be carried. And the unsatisfactory surface meant that the other aircraft could only take twenty-two altogether – the sick and the women. Within three hours all three were on their way back to Tiksi.

The lesson was clear: before the aircraft returned there must be a better landing-ground. So the weary constructors set off to prepare strip No. 4. This was a good site, long known about, but ruled out because it was nearly five miles away. But now that the sick had been removed, distance did not matter, and in a few days the strip was ready. Bad weather held up the aircraft, however, and the extra time was used to tidy up No. 3, which could be made usable again because the cracks had frozen up. So when the aircraft were able to return, which was not until 18 April, there were actually three alternatives for them to choose from.

They chose No. 4, the newest. Only two came. The flyers had thought it best to establish an advance base on Ostrov Ko-

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tel'nyy, thus cutting down the length of the flight to the ships and back by 600 miles, which was about half. But there was no petrol on Kotel'nyy, so the third aircraft had to spend most of its time ferrying petrol up from Tiksi. The two that went to the ships on 18 April were able to take on board eighty-three passengers, and less than an hour and a half later they were on their way back. The weather was bad, but the flight was successfully completed.

This still left seventy-nine winterers who were due for evacuation. The weather remained poor, and this unlucky group, whose hopes had been raised for so long, wondered if it was ever going to get away. At last, on 26 April, the two aircraft unexpectedly flew out. It was overcast and cold, and quite late in the evening. But all the passengers got in, and the aircraft disappeared for the last time.

To the outsider, and to some of the people on the spot, not all the cruelly hard work of air-strip making seemed entirely necessary. The dimensions given – 1,000 yards by 1,000 yards – were no doubt highly desirable; but an aircraft can land on a strip 1,000 yards by 50. If narrow strips had been concentrated on from the start much labour would have been saved. Some idea of just how much can be got from the fact that levelling a passage 150 yards wide through an old ridge necessitated shifting 5,000 tons of ice.

The camp of the three ships was very different now. Thirty-three men were all that remained: eleven in each ship. Six weeks before, there had been a reorganization among the crews in preparation for the evacuation. The *Sedov* was particularly affected. Her old crew were not wholly satisfactory. She had been frozen in for the winter in a bad place, and as a result was constantly in danger and sometimes damaged. An energetic captain was required if the ship was to have a chance of sailing again. So her elderly and ill master was replaced by the twenty-seven-year-old Badigin, who had shown drive and spirit earlier in the winter and as chief aerodrome constructor. As soon as he had taken over he saw that changes were needed in the crew too, and he picked replacements from the other ships.

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Although the convoy was now north of the 80th parallel and about 500 miles from the nearest point on the mainland, preparations were made for the navigation season. In this particular part of the Laptev Sea the ice had been known to retreat far to the north in the late summer; the *Fram* did not enter ice until she had nearly reached 78° north. So the preparations for sea were not just a booster for morale. There was some doubt about the *Sedov*. It was likely that her rudder had been damaged by the ice; this would have to be inspected. But it was certainly not impossible that the ships might be reached by one of the big icebreakers in the summer and led south.

If this did not happen, and the drift continued, supplies were now sufficient. With so many people gone, the food would last for over three years. The aircraft also brought up some badly needed items, although they could not of course carry very much. There was a mistake over this, as it happened. The crews left with the ships eagerly broke open the cases which arrived, and found such supremely irrelevant things as tractor spare parts and apparatus for investigating soil samples. But happily this piece of faulty addressing was not a matter of life and death.

For the men in the *Sedov*, many weeks of laborious work were spent on the rudder. Divers were sent down – an unpleasant job and one which involved some risk of ice fouling the air line – and the damage was found to be rather bad. The rudder was broken in two, and so was the stern post supporting it. All sorts of ways of unshipping the rudder were tried, but in the end it had to be admitted that the job could not be done with the equipment they had. This failure did not stop the other preparations. The engines were overhauled and got into good order, and all other equipment was checked and cleaned. By the middle of August everything was quite ready. The rudder had been made to work to a limited extent (it would not turn more than 10° to each side), the ice was rapidly melting, and everyone in the convoy was waiting for the signal announcing that an icebreaker was on her way to them.

The news came on 20 August; and a week later the icebreaker

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Yermak crashed and buffeted her way to the three ships. They met in latitude 83° 04' N., longitude 138° 02' E. – less than 500 miles from the North Pole. It was a great feat on the part of the *Yermak* to get there, for no ship under her own power had penetrated as far north as that before. She was helped by finding open water as far north as Nansen had found it, and even a little further; but by way of compensation for this good fortune, the ice close to the ships was very difficult. She arrived, however, and at once broke up the ice round the ships and transferred coal to those that needed it. Then she came across to the *Sedov* and took her in tow, while the other two ships, moving under their own power, followed in the wake of the *Sedov*.

So on the evening of 28 August everything seemed fine. The thirty-three winterers were jubilant, with the powerful *Yermak* leading them towards open water. But they had not been going for long when the tow-line snapped (one had already parted before they got moving at all). Another was quickly fixed in position, and the ships moved slowly ahead. But the strain of breaking heavy ice with a more or less helpless ship in tow was tremendous even for the *Yermak*. Forty minutes later the tow-line broke again. The process of securing a new line, grinding ahead a few hundred yards, and then securing another new line, was repeated several times. In two hours they had not yet gone one mile. The situation began to look black. The *Yermak* cast off the tow-line and went to look for an easier route through the ice. Then another blow fell. The *Yermak* radioed to say that she had lost a propeller in the ice, and could no longer tow at all.

The only remaining chance for the *Sedov* was to be towed by the *Sadko*. This was suggested, but it was not even tried because it was so unlikely to work, and every minute wasted endangered the escape of the other three ships. So the decision was taken to leave the *Sedov* to drift. For a short while it was suggested that she should be abandoned. One can well understand how attractive this idea may have seemed at the moment to the crew. But a few weeks later it would have been very difficult to explain. The crew, it was then decided, must be left

aboard and increased to fifteen. The *Yermak* was to provide necessary additions or replacements.

Captain Badigin announced this to the men of the *Sedov*. It must have been a bleak moment. Another wintering ahead, with the memory of the last one still green; and then, who was to know, perhaps another after that? The announcement was followed by urgent and anxious discussion. Some had an excellent case for returning; others volunteered to remain. Minds had to be made up, replacements requested. In the end eight of the old crew stayed on; one man came from the *Sadko* and six from the *Yermak*. At the same time stores had to be brought across and all the things the *Sedov* was short of had to be thought of and asked for, and all this had to be done when no one had had any sleep for forty-eight hours.

At half-past three in the afternoon of 30 August there took place what was surely one of the hardest of Arctic farewells. The *Yermak* led off the *Sadko* – the *Malygin* had gone on ahead – and the *Sedov* remained. For the nine members of her crew for whom this was the beginning, in effect, of a second year in the Arctic Ocean, the poignancy of hopes deferred was perhaps slightly dulled by the overwhelming desire for sleep; and ten minutes after the ships had parted all but the duty watch were dead to the world.

So the *Sedov* drifted on alone. The loneliness was acutely felt by all aboard her. But once again it was abundant hard work which diverted their attention. The ship had to be laid up for the winter in a safe place. Last winter's alarms were a vivid memory. Badigin selected what seemed to him to be a good site; but it meant moving 100 yards to reach it. That in itself, with the broken rudder, was not easy. When it was done, the new 'quay' was organized and emergency stores were laid out on the ice. Inside the ship new arrangements had to be made to accommodate the extra crew, make room for a laboratory, and so forth. In the engine-room the engineers went ahead with the big job of laying the engines up for the winter.

But just as the quiet routine was easing the tension of a week or so before, everyone's peace of mind was again destroyed by

the news that one more attempt at relief was to be made. All knew that the newly completed icebreaker *Iosif Stalin* was to make her maiden voyage in the Arctic this summer. And they surely thought, even if they did not dare admit it to themselves, that it would be a magnificent start if she could begin her career by performing the almost impossible and rescuing the *Sedov*. To the authorities also this seemed too good a chance to miss. The first rumour that something of the sort was afoot reached the *Sedov* on 9 September. During the next few days weather reports were called for from the mainland at frequent intervals because a special ice reconnaissance flight was to be made. Then on the 14th the radio operator received the laconic and exciting message from the *Stalin*:

‘Get ready your engine, await instructions to raise steam.’

In spite of the excitement of the moment, Badigin could not avoid raising doubts. He signalled back that he could not steer his ship, and that two icebreakers, not one, would be necessary to help him out. On the 17th the answer was received:

‘Obtained permission to proceed to *Sedov* with two icebreakers.’

The *Litke* was to come with the *Stalin*. Expectancy mounted. Best of all, the ice looked much more favourable now than in the first half of the month.

The relief ships forged their way northwards. At first it was easy going, and then on the 22nd serious difficulty was encountered with the ice. Round the *Sedov* the ice had already got worse a few days earlier, and the outlook was bad. But the *Stalin* kept on until she reached the 83rd parallel and was only sixty sea miles away from her objective. At this point the risk of being caught became too great. She checked with the *Sedov* that the ice was also bad at the other end, and then sent a final message to the drifting ship:

‘Have permission to return. Am proceeding to Mys Chel-yuskina.’

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So it was all over. And, to make matters worse, as soon as she had gone the ice round the *Sedov* rapidly improved. Once again the crew had been cruelly disappointed, and this time it must have been worse than the time before.

Events gave very little time for reflection, however. Two days later, at eleven o'clock at night, the ice moved and the ship took on a list of 18°. The reason for the size of the list seems to have been that a large amount of ice was frozen on to the bottom of the ship unevenly; so that when the floes supporting her moved, the effect of this weight was felt. An outlet valve, now below water level and not working properly, began to let in water at an alarming rate. The list increased and within an hour it was 30°. This was the critical point; a little more, and all the freight would break loose, increase the list still more and that would be the beginning of the end. There was feverish activity. Engines had to be started to give power to the pumps, the hole had to be sealed off with cement, and all this had to be done with the boat leaning over on its side, and, at least to begin with, in almost total darkness. Steam was raised in record time, and not a moment too soon; for half an hour afterwards the ice moved again, but fortunately the list had by then been reduced by pumping to 18°.

At seven in the morning the situation was sufficiently restored for the cold, wet, and utterly weary crew to have a few hours' sleep. There were no more alarming moments after this, and normal routine was gradually restored. But it was thought wise to unload a great many more stores on to the ice, just in case the expedition should not get out of the next crisis so successfully. And as another safety measure, a duplicate set of emergency stores was piled up on deck ready for quick unloading in case the first dump was lost.

The attempts of the summer of 1938, successful and unsuccessful, to relieve the drifting ships contributed one quite incidental piece of knowledge to the geography of the Soviet Arctic. 'Sannikov Land', a mysterious island first reported in 1811 by Yakov Sannikov and twice later confirmed, was to all intents and purposes proved not to exist. The place where it

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should have been had been crossed by the drifting trio, the aircraft and the icebreakers, and no one had seen anything. It is true that there did remain two small patches of unexplored ocean which were not flown over until 1944, but they were really outside the region that Sannikov and his successors, De Long and Toll, could possibly have seen.

The fact that Sannikov Land does not exist does not necessarily mean, curiously enough, that these three were imagining things. They might well have seen an island, or ice piled up on an island. For small islands in this part of the world consist quite largely of ice; ice is the binding agent which holds the soil together and gives it rock-like consistency. If the ice melts into water, the 'rock' becomes mud and the island disappears. Two islands in the Laptev Sea called Vasil'yevskiy and Semenovskiy have disappeared in this way within the last twenty years. They are part of the evidence that the Arctic regions have been getting warmer recently. So it is possible that 'Sannikov Land' was another of these.

On 10 October the sun appeared above the horizon for the last time. The ship was drifting north of the 84th parallel, and at this latitude the sun is not seen for about four and a half months. The wintering had begun in earnest. With the essential practical preparations complete, the task now before the ship's company was to make the best possible use of the fact that they were passing through a part of the world about which very little was known. Here of course they came up against the fundamental difficulty that the voyage was not intentional and no special preparations for this sort of situation had been made. There was only one man with scientific training – the hydrographer V. K. Buynitskiy, and he was no more than a student, though a capable one – and very little equipment.

The only thing was for Buynitskiy to do the more complicated observations: astronomical, magnetic, and gravity measurements. The instruments were available because Buynitskiy brought them with him from the *Sadko*. The rest of the crew could be trained to do something useful but less complicated: meteorological observing, measuring ice thickness, taking

soundings. A full programme was worked out. The meteorological observations were to be made every two hours, which would impose quite a burden; but the feeling was that this would be well worth while, since there was no other weather station within hundreds of miles. Instruments presented the greatest difficulty. There were not enough for everything. Improvisation could help somewhat, and did; but one cannot improvise a thermometer. Everyone turned to with remarkable enthusiasm and the programme was soon under way.

The hydrologists had a very cold time of it, with their sounding line and thermometers continually freezing up. Buynitskiy, as the one qualified man, was the hardest worked. His diary for one day makes this clear enough:

'From midnight to 4 a.m. on watch, then astronomical observations and calculation of coordinates. After breakfast gravity observations, developed film record of pendulum swings. At midday, magnetic observations; spent five hours on the ice, index finger slightly frost-bitten; back to ship, on watch again. It is now 9 p.m. I will finish my diary and start working out the magnetic observations.'

He had a hard time, too, with those magnetic observations. His 'observatory' was a small snow house built at the opposite side of the floe from the ship. This was because of the need to reduce possible distortion by local metallic masses. For the same reason he could not take any metal objects to his house, and this included his gun. So whenever polar-bear tracks were seen, one of the sailors on watch would be detailed to keep guard over Buynitskiy while he was making his observations.

Material comforts in this second wintering were greater than in the previous year. With only a fraction of the number of people aboard, there was no need to stint the stores. Cabins that had been barely heated before were now comfortably warm. Food was plentiful. Some commodities were more than that: the soap supply, it was estimated, would last eight years.

As in the preceding winter, radio contact with the mainland

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was a big factor in morale; and participation in national events was continued for the same reason. The technical side of keeping this contact was quite easily arranged: the ship's radio could receive Moscow direct, while transmission to Moscow was handled by a series of weather stations – as the ship drifted away from one station the next would take over – which passed on messages. The crew started right off by sending a message to the youth newspaper *Komsomol'skaya Pravda* in celebration of International Youth Day. Radio contact was lost for a few days after this, and when it was established again they found they had sent their message five days too early. This of course was excellent for morale; another celebration was held on the right day.

The first anniversary of the drift approached. It soon became clear that this fact was causing something of a stir back home, too. Telegrams kept coming in from newspapers demanding copy. The Moscow broadcasting committee wanted to know each man's favourite pieces of music, because there was to be a special programme on the day. On board there were suitable celebrations. The food stores were ransacked to try to find something new and exciting; the radio operator Polyanskiy concocted drinks by mixing spirit with fruit-juice and even vitamin pills. The festivities were interrupted while the captain was called to the radio cabin to give an interview to a Novgorod paper; this mystified him at first – how had Novgorod, the other side of Leningrad, got hold of him? – until he found that the wily editor had enrolled as his special correspondent the radio operator at Mys Chelyuskina weather station. Then came the high point of the evening: the radio programme. Everyone was delighted, and the party broke up in the small hours. The real climax however was reached when a telegram came from Stalin and Molotov. Excitement knew no bounds; but owing to the Kremlin habit of working in the middle of the night, the telegram did not reach the ship until the next day. This small point in no way inhibited the release of emotion, nor prevented the immediate sending of a fervent reply.

There were plenty of other celebrations of red-letter days in

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the Soviet calendar. New Year's Eve was a very special occasion, when a broadcast by relatives to their menfolk was arranged, followed by the men's replies. This was done again in the summer. But, by and large, there was little leisure time. In the expectation that there would be more than there was, the ship accepted a challenge at radio chess from the station at Mys Chelyuskina. But this game went on for a whole year, finally provoking from the challengers the message: 'If anyone asks you how long it takes to drift across the Arctic Ocean, you may reply – not longer than a game of chess.'

There were more alarms about ice pressure during the winter; but none of them so critical as the 30° list of early October. Pressure waves would be seen advancing towards the ship. Sometimes they would miraculously stop just before they reached her. The hull would creak and groan as the blocks of ice piled up against it, but the massive wooden 'ice-beams' which had been put in place at the beginning of winter to strengthen the internal bracing of the ship took the strain well.

On one occasion the old floe which served as 'land' to the ship and on which the emergency stores were kept was subjected to extreme pressure. A crack in the ice appeared inside the tent covering the hole used for the hydrological observations, just as the men were working there. They had scarcely jumped across it before it widened to three yards, and the table on which they had been taking notes disappeared into it. Buynitskiy and his bodyguard were all but cut off from the ship. The first set of emergency stores, already on the ice, were carried up to a mile away, some dumps going in one direction and some in another. The difficulty was that with all the surrounding ice moving, it was impossible to know where to put the second set. When the movement subsided, the stores on the ice had to be found – no easy job – collected, and put on a new floe which it was hoped would be more stable. This moving of stores over the confusion of new hummocks and ridges took three days of very arduous work, some of it in dim twilight and some in total darkness. The magnetic 'observatory' disappeared altogether; it simply could not be found again, so a new one had to be built.

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And then, within three weeks, another big movement threatened the new emergency dumps. All hands turned out to the rescue, and this time fortunately it was not such a strenuous job. The big floe on which the stores were laid out split up, and it was a question of moving them to the biggest and most solid-looking of the pieces. This done, there were some weeks of quiet and no more emergencies interrupted the cycle of scientific observations for the time being.

January 1939 was a cold month at 85° north. Up to then there had seldom been temperatures below -13° F. But in January there was often a 50° frost. The coldest day of the whole drift was the 11th, when the thermometer read -46.3° F. This is undeniably very cold, and we who live in western Europe will never know anything approaching it if we stay at home. But curiously enough this is by no means as cold as it can get in the polar regions, although it is almost as far north as one can go. The central Arctic is all sea, and the sea always has a moderating effect. The really cold places are those far away from the sea. That is why the coldest place in the northern hemisphere is in fact not even inside the Arctic Circle. It is the settlement of Oymekon in north-eastern Siberia, about 250 miles south of the Circle. The explanation is that this place combines several reasons for being cold: it is remote from the sea, reasonably far north, and quite high above sea level (about 2,500 feet). What causes it to break the record is that it lies in a hollow, so that when there is not much wind the cold air – which is heavy – collects there and gets colder and colder. The lowest temperature recorded is about -90° F.; and the average for February, the coldest month in the year, is in the region of -58° F. The centre of the Antarctic continent has long been thought to be still colder; it is further from the sea, nearer the Pole, and higher up; until very recently no one had ever been there in winter to find out, but on 17 September 1957 the American International Geophysical Year party at the South Pole registered -102° F. – up to now the record.* The average

* But beaten on 2 May 1958, when -109.1° F. was recorded at the Soviet inland Antarctic station 'Sovetskaya'.

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for July 1957 was -77° F. So although the crew of the *Sedov* found it exceedingly cold, and we should have found it even colder, they were not breaking any records.

When the *Yermak* was about to leave the *Sedov* behind the previous August, there had been talk of organizing a relief expedition by air the next spring. Naturally enough, the thought of relief in the spring helped everyone to get through the second winter. In January there was a quickening of pulses when the telegram came from Moscow.

‘Give details of ice situation, possibility of aircraft coming in, preparation of aerodrome.’

Things were evidently really getting under way. The idea was to fly in a relief crew, to whom the ship could be handed over. Since the aircraft would only be able to wait one hour, everything would have to be so well arranged that the handing over could be completed in that time. So there was plenty of work to be done. The relief aircraft would also bring specially needed stores. Lists of these were carefully worked out.

But somehow the captain felt uneasy about the whole thing. Was it right to leave one's ship in these conditions? After all, the worst must be over now; was it not rather unworthy to leave before the job was finished? He decided to talk to each of the men in turn and find out how they thought. He found that three of them felt the same way as he did; the other eleven would prefer to return home, but added that they would stay ‘if it was necessary’. The captain took it upon himself to radio back that everyone's morale was excellent. He must have known that this would provide just the cue that was wanted. Three days later Papanin, now the Head of the Northern Sea Route Administration, answered:

‘. . . I feel that the men of the *Sedov* are ready to carry out any task given them by the Party and the Government. As a polar man, as your friend, I want to put a job before you – to carry through a historic drift to its end by your own resources, with the unshakeable resolve of real Bolsheviks. . . .’

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The crew were called together. The captain told them what had happened, asked them what they were going to do, and said that he himself would stay. After some talk they all agreed to stay too.

What is one to make of this incident? Certainly there was the desire, in Moscow, to extract the maximum publicity value; a good example of unshakeable resolve was just what was wanted a short while before the 18th Party Congress and a short while after the purges and the talk of traitors. (The telegram announcing the decision to stay was published immediately on the front page of *Pravda*, and the fullest possible use was made of it thereafter.) But out there on the *Sedov*, what made eleven men change their minds? There was certainly no compulsion, unless one calls an invitation to decide in the presence of one's fellows a form of compulsion. One must conclude that the desire to do 'the right thing' really was stronger than the desire to go home, even after more than eighteen months, and let it stand to their credit. A remnant of the scheme did survive. In April an aircraft was sent to Zemlya Frantsa-Iosifa to be in readiness if the expedition should need help in an emergency.

In the spring Badigin was very eager to organize a sledge trip. He wanted to establish a camp about seventy-five miles to the north of the ship, keep in radio touch with it, and by radio direction-finding see what differences there might be in the drift of the ice at the two places. The object was sound: it would be useful to know something on that point. But in the opinion of Buynitskiy, to whom the leadership of the sledge party was offered, there were innumerable objections: the equipment was unsuitable, navigational instruments were lacking, the scientific programme at the *Sedov* would be interrupted. Badigin, nettled, said that the initiative of the leader was all that really counted, and declared he would lead it himself. But in the end, as Buynitskiy guessed, the sledge party never left.

It was in March 1939 that the hydrological team finally succeeded in taking a sounding. The necessary 5,000 yards of strong, thin cable had had to be improvised. Eight unsuccessful attempts at sounding had been made; each time either part of

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the cable was lost and sometimes a precious thermometer with it – or it was not long enough. Now the bottom was reached at 4,485 metres. It was really something of a triumph, and there was every reason to hope that soundings could be made in the future for every twenty sea miles of distance drifted. Things did not work out quite that way, for the next three attempts were unsuccessful. But there was considerable improvement later.

About this time the speed at which the ship was drifting got markedly faster. Early in April the *Sedov* was north of Severnaya Zemlya; by the end of the month she was 180 miles further west, in the longitude of the mouth of the Yenisey. It seemed that the force of the Greenland current, which carries ice and water out of the central Arctic through the strait between Spitsbergen and Greenland, was beginning to make itself felt. Hopes of early release – earlier than had been thought before, anyway – came into everyone's head. The ship was once again made ready for sea-going.

Badigin was chiefly worried about the rudder. It had been mostly because of the bent rudder that the *Sedov* had been left behind the summer before. The same thing could easily happen again. It was vital to do something about it. Divers had been down in the summer and had estimated the damage by feel. Now, before the ice melted, was the chance to examine the rudder out of the water, provided the ice could be chipped away sufficiently without letting any water come through into the space cleared. This was done, and most of the rudder was laid bare. It was decided to cut the rudder in half, leaving the lower, bent portion as it was and allowing the upper part to swing freely. After much difficulty, this was successfully accomplished. The whole operation had really been left too late in the season – it was now early June – because the thaw was starting and water was continually coming in through the thin ice walls of the hole hollowed out of the ice. It was a great relief when the job was finished.

The ship was also painted and thoroughly spruced up. There was difficulty about drying oil – the ingredient in paint which helps the drying process. There was none on board. But some-

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one had read somewhere that if one boiled sunflower oil, that could be used instead. There was plenty of sunflower oil (used for cooking), and after some foul-smelling experiments the method of conversion was discovered.

The ice by the middle of the summer was a good deal more favourable for navigation than it had been the year before, although the ship was now considerably further north. At the beginning of August the ship was north of Ostrov Rudol'fa, the polar station and air base in Zemlya Frantsa-Iosifa. Everybody was hoping that there would be another attempt to reach them by icebreaker. But in fact none was made. There had evidently been some tentative planning, but that was all. It would certainly have been difficult to arrange, since it was at the end of August that the *Sedov* reached her furthest north — $86^{\circ} 39' 30''$ N. and $48^{\circ} 22'$ E., or 230 miles from the Pole.

Meanwhile the aircraft was still waiting at Ostrov Rudol'fa for the emergency call which never came. The aircrew were keen to fly to the *Sedov* and at least drop supplies, even if they did not land. But Badigin thought it unnecessary to do this while there was still a chance of an icebreaker relieving his ship; and by the time it became clear that that chance was definitely not being taken, the weather was deteriorating, the light was beginning to go, and in the end it proved impossible to make the flight without taking quite a risk. The men of the *Sedov* felt that it would be ridiculous in these conditions to fly in stores which were not absolutely essential, and they unselfishly asked for the flight to be abandoned.

So the ship drifted on towards the Greenland Sea. There was gloomy foreboding about what might be expected to happen there. The Greenland Sea, between Spitsbergen and Greenland, is the only way out for the ice of the Arctic Ocean. The current is faster here, and ice from the central Arctic is sucked into it in greater quantity than there is room for. So there is much pressure, much jostling, and splintering of giant floes. Whatever adventures the *Sedov* had had up to now with the ice were likely to be trifling compared to those in store in the Greenland Sea. So all precautions were taken. Emergency

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stores were once again unloaded on to the ice. Fuel was more strictly rationed, so that there would be enough coal to make a dash for open water if the occasion arose.

The feelings of the ship's company as their third winter at sea started can be imagined. Little is said about this in the narratives, but the strain must by this time have been great. Physically they were losing condition. There was almost universal neurasthenia, and weak hearts were quite common. Work was cut down to five hours a day, but in the free time Badigin wisely organized courses in engineering and navigation. These took up to six hours a day. Arrangements were even made for examinations to be taken on board, but in fact the drift ended before anybody was ready to sit for them.

The start of winter brought a sharp drop in temperature. One of the inconveniences this caused was to freeze solid the hosepipes lying on deck. It was impossible to get them down below into the warm because they were as rigid as iron bars. The captain was worried about this because the hoses might be needed urgently in case of fire. Then he had a brilliant idea. The hydrological observations had shown that about 100 fathoms beneath the cold surface water of this part of the Arctic Ocean there is a layer of warm water which has been brought in from the Atlantic by the Gulf Stream. When one says warm water, one means warm by comparison; for its temperature is not more than 2° F. above freezing. But this was enough, Badigin realized, to thaw out his hoses. So he ordered some astonished seamen to lower them through the hole in the ice; and sure enough, two days later they were hauled up thawed.

Moscow continued to arrange effective morale-raisers. The second anniversary of the start of the drift was marked by another broadcast by relatives, another telegram from Stalin and Molotov, and a special speech by Kalinin over the radio telephone. The 22nd anniversary of the Revolution was another great occasion a couple of weeks later. And then soon after that elections to local Soviets took place. On previous election days the fifteen men had recorded their votes with great seriousness. But this time they not only voted, but were candidates. They

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were all put up for the Murmansk town Soviet, and Badigin was also nominated for the Moscow city Soviet. The nominations were accepted with much emotion; and it is an interesting side-light on a Soviet citizen's reactions that the results of the elections were not even mentioned in either of the published narratives. As Badigin never tires of saying in his, only in the Soviet Union could such events take place. On this occasion at least he is absolutely right.

Although there had been every expectation of an uncomfortable time in the ice as the ship neared open water, the months of October and November were entirely free of the slightest sign of pressure. But in December it started, and became as bad as anyone had feared. The sudden alarms, the narrow escapes, the feeling of helplessness in the face of millions of tons of moving ice – all had been forgotten during the summer and were now back again. At one of the more difficult moments, when all the ice round the ship was drifting in a curious rotatory movement and the floe with the emergency stores had been carried off several hundred metres, a telegram arrived from Moscow:

‘For making uniforms of crew radio size of jackets, trousers, overcoats, boots, head-dress and men’s names.’

This was probably the best help the outside world could have given. The general anxiety was broken by hearty laughter; and the necessary dimensions were measured by the doctor, who sent them all back in anatomical terminology.

In the middle of these difficulties word was received that the end of the long ordeal was in sight. On 10 December the radio announced that the *Stalin* would soon leave Murmansk to meet the *Sedov*. Rumours had been circulating about this, and confirmation delighted everyone. Before long the *Stalin* was reported in the Barents Sea, and on the 22nd, when she passed round the southern end of Spitsbergen and entered the Greenland Sea, direct radio contact was made between the two ships. By the 24th there was only eighty-four sea miles between them; but they were filled with ice so tough that the *Stalin* could make

no headway at all. However, the *Sedov* was drifting southwards faster and faster; on that day thirteen sea miles were covered. The *Stalin* returned to Spitsbergen to refuel.

Sea-going preparations were now in full swing. In spite of the tremendous strains imposed there was no serious damage to hull or engine. The Glasgow shipbuilders who launched the ship in 1909 would have been proud of her. One of the problems was finding water to put in the boilers. The inlet valve in the ship's side, below the water-line, had to be cleared of ice at a time when there was movement among the floes and the working party was in real danger of the 'ground' giving way under them. But it was successfully done. The engineers were so busy in their department that the captain had to insist that they kept to an eight-hour day in order to conserve strength for possible emergencies.

On the morning of 3 January 1940 Butorin, the boatswain of the *Sedov*, noticed far to the south-east a curious patch of bluish light in the sky. Could it be the *Stalin's* searchlight? Badigin quickly got on the radio telephone to the captain of the *Stalin*: would he please shine his searchlight vertically upwards? Everyone ran up on deck, and to their intense excitement saw the patch of light move until it pointed upwards from the horizon. By that afternoon there was less than twenty-five sea miles of ice separating rescuers from rescued.

But those few miles took ten days to cover. The curious thing was that during most of that time the *Stalin* was unable to move in ten-tenths ice while the *Sedov* was embarrassed by the great amount of open water. In fact she was gently rotating, an island in the middle of a lake. In this way she avoided getting into pressure, but there was the disadvantage that it was no longer possible to reach snow for drinking-water. Someone had to 'board' any small floe that drifted past, and get as much snow as possible before it drifted on.

Finally, on the morning of the 13th, straining eyes on the *Sedov* were rewarded by the glorious sight of the blazing lights aboard the *Stalin*, approaching them through the fog. A few minutes later and the ships were side by side, with the air full of

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greetings and cheering. The *Sedov* had come to the end of her long drift: 3,800 miles in 812 days.

After taking aboard coal, the ships set out for home. At first the *Sedov*'s rudder gave trouble, but that was soon put right, and it was found that she could deal with ice just as effectively as she had been able to before. The engineers were justly proud of their work. In a few days Murmansk was reached, the voyage was over, and the junketings – richly deserved – began.

The value of the observations obtained with so much toil cannot yet be fully assessed; because, of the four volumes of scientific results that were to be published, only one has come out. But there have been preliminary reports (a preliminary report of an expedition generally appears within about three years; the full report may take forty, if indeed it comes at all), and they have been full of interest.

One of the most obvious and also most valuable results was the actual course of the drift. Buynitskiy was very assiduous in getting astronomical fixes – the average worked out at one every other day – so that there is a reliable and detailed chart showing the ship's movement across the Arctic Ocean. The striking thing about it was the speed. Nansen had followed a very similar course in the *Fram*, but had taken half as long again to make it good. This fact, together with the weather observations, has been used to reinforce the theory that the Arctic has been getting warmer in the last thirty years or so. For the air temperatures recorded on the *Sedov* were a good deal higher than Nansen's figures, especially for the winter months (the annual mean was about 7° F. higher, that for the winter 14° F. higher); and the increased speed of drift indicates stronger winds and more broken-up ice – both evidence of increased storminess which results from more warm air coming into the Arctic.

Of course, the ship did not drift in a straight line, or anything like it. She made zigzags and loops and figures of eight; this was due to the local winds, which drive the ice before them. The precise effect of the wind on the ice movement is something worth while finding out about, because if it can be discovered it will help somebody who knows what the weather is doing

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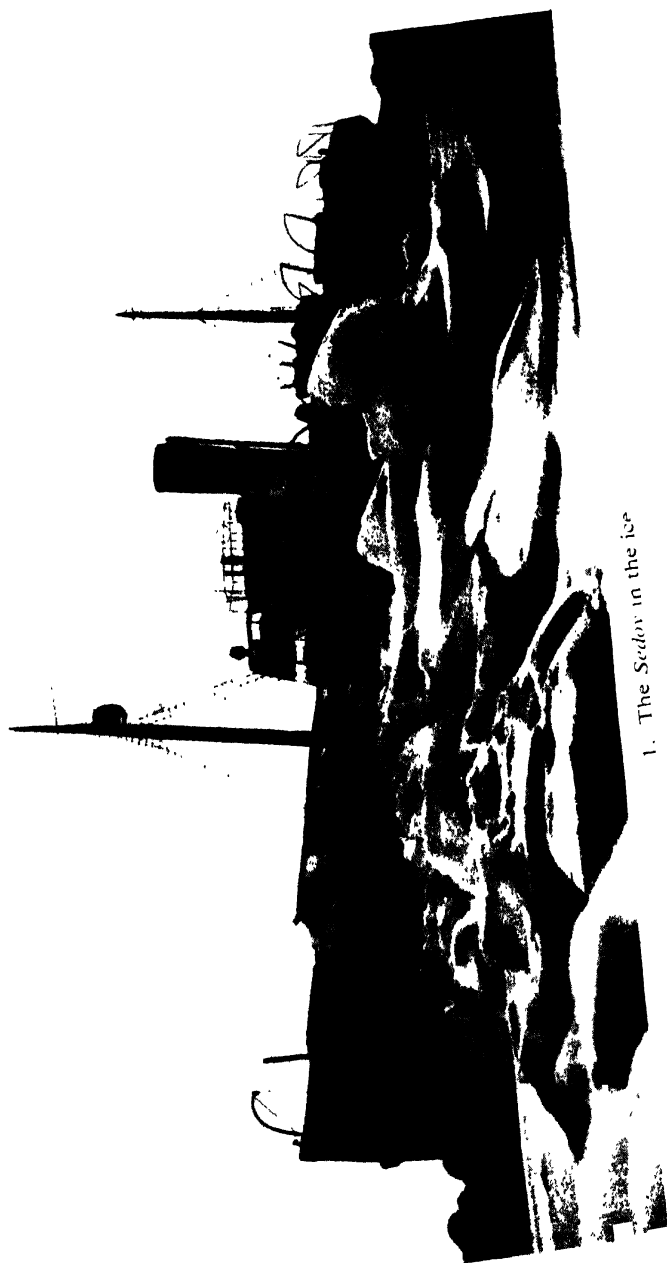
to predict the state of the ice. This is a point that has been taken up in some detail by the Russians, because it is very much in their interest to be able to forecast what the ice will do along the shipping lanes of the Northern Sea Route.

The fact that the *Sedov* crossed the course of the *Fram* several times in the two years was a very happy chance, because it allows one to compare observations of various sorts – sea-water samples, gravity, or magnetic measurements – for almost exactly the same spot forty-four years later. But very little detailed work on this has yet come out.

The soundings, made at the cost of so much effort and with improvised equipment, were well worth while. For whereas the greatest depth measured by Nansen was 3,850 metres, and Papanin's North Pole party found a maximum of 4,395 metres, the *Sedov*'s men failed to touch bottom at 5,180 metres, and found a number of depths of over 4,500 metres. The deepest point was at $86^{\circ} 26' \text{ N.}$ and $39^{\circ} 25' \text{ E.}$ – about 375 miles northwest of Zemlya Frantsa-Iosifa. This was not the greatest depth ever measured in the Arctic: Sir Hubert Wilkins had found 5,440 metres in the region north of Alaska. But, as we shall see later, this observation was almost certainly wrong, and the deepest part of the Arctic Ocean that we know of is the region where the *Sedov* recorded her maximum.

The soundings were also able to confirm the existence of a submarine ridge along the floor of the Arctic Ocean between Greenland and Spitsbergen. Nansen had supposed it existed, and other people had crossed it in other places, but the *Sedov*'s information establishes it still more firmly.

The only volume of results that has made its appearance is volume 3, *Biology*. There was no biologist on board, so the only information about birds and animals comes from notes in people's diaries. This is probably quite reliable, as far as it goes, because any sign of life was a great event and not likely to go unnoticed. So there is a record of the sea-birds, bears, arctic foxes, seals, and narwhals that chanced to visit the *Sedov*. It may be surprising to hear of bears and foxes wandering so far from land, but Nansen had found the same thing.



1. The Sadoy in the ice

Most of the volume is taken up with marine biology: analysis of the bottom samples and plankton hauls that the expedition brought back with them. Bottom life was particularly rich, and all sorts of new species were found, but the plankton contained no special surprises.

There is one particularly interesting aspect of the expedition on which it is very difficult to form an opinion: the atmosphere in this tiny, isolated society, the personal relations. In some ways this is very important, and it is certainly fascinating to the outsider. It is always difficult to find out about, because all writers of expedition narratives like to give the impression of one big, happy family, where an angry word is never spoken. This is true of writers of all nationalities, but it is particularly true of Soviet Russians.

Badigin and Buynitskiy are the two diarists. Badigin, capable, efficient, clearly a good leader, and equally clearly a very good Party man, omits practically everything which might give us a clue. Buynitskiy, conscientious, keen, the scientist among laymen, and anxious to prove himself, is very laconic, but probably more truthful. He drops a hint or two about some of the tensions that existed.

There can be little doubt that Badigin got on people's nerves at times. Of course, in the nature of things, one would expect it. He had to give the orders, and orders always breed some resentment, no matter how much goodwill there is. His youth would not have made things easier. Reading the narratives, one realizes that his behaviour over the aerodrome construction in the spring of 1938 infuriated some: it was he who insisted on making the landing areas as wide as they were long, quite unnecessarily. As captain he made some errors of judgement: the repair of the rudder was started too late in the season; the flight from Zemlya Frantsa-Iosifa in 1939 should have been called for earlier. This in particular must have enraged everyone. But he must not be blamed. He had a right to make his mistakes, and if he did make them, that does not in the least mean that he was an ogre, loathed by all. He is also justified in not mentioning any feelings of this sort; after all, he never says

a word to the detriment of his crew, who must have irritated him at least as much. These omissions can be accepted because they may spare feelings. But he goes further, sometimes, than mere omission. He implies that Bolsheviki have such a keen sense of service to the collective that feelings like this simply could not be generated. Once this is said, credulity is strained to breaking point and one begins to wonder about other things, too.

For it is impossible to deny that there was a propaganda value which was used to the fullest extent. As we have seen, the crew produced an example of Bolshevik determination at a convenient moment. Telegrams to Stalin on the occasion of public holidays were always couched in language which *Pravda* could not have bettered (and which it hastened to reproduce). The behaviour of the *Sedov* men, good by any standard, was also just what Soviet leader-writers and radio commentators were looking for. So one would expect Badigin to follow the same line in his book; in fact, he could hardly have done otherwise. His speeches to the assembled crew on State holidays have to be read to be believed. His account of the crew sitting round listening to the *Short History of the All-Union Communist Party* being read to them over the radio has perhaps a moment of unintentionally truthful comment in it, when he describes these readings as the 'quietest hours on board'. The paternal helpfulness of the State was continually stressed, it being apparently thought that this attitude offered the most striking contrast to the way bourgeois expeditions were let down and even abandoned by their capitalist supporters.

Nevertheless, whatever use may have been made of the story, the basic facts are not in dispute. The whole drift, without any doubt at all, reflects very great credit on the fifteen men who endured it. They faced many dangers, overcame many difficulties, and showed remarkable tenacity of purpose, and yet they were neither selected for the task nor trained for it. They had plenty to do in protecting their ship from the ice. But they went far beyond this, and their resolute efforts to extract from their predicament material of great value to the scientists of the world are worthy of unreserved praise.

CHAPTER TWO

The Pole of Relative Inaccessibility

Vilhjalmur Stefansson, the well-known American explorer and writer on Arctic subjects, introduced in 1920 the concept of a 'Pole of Relative Inaccessibility'. He was thinking of the point in the Arctic which would be most difficult for an explorer to reach, after coming as far as he could by ship and then transferring to sledge. Stefansson marked on a map the most northerly points known to have been attained by ships, and placed his Pole of Relative Inaccessibility in the centre of the ring formed by these points. It is about 450 miles on the Alaskan side of the geographical North Pole. This 'Pole' does not have any permanent geographical significance, because the most northerly points reached by ships are always changing, and the method of travel changes also. However that may be, it remained true up to the outbreak of the Second World War that the vicinity of Stefansson's 'Pole of Relative Inaccessibility' was the part of the Arctic Ocean about which least was known. Some flights had been made across it, and Sir Hubert Wilkins in 1927 had even landed on the ice and measured the depth of the sea at one point. But it remained an almost unsullied 'white spot' on the map.

The idea of making an expedition to this region occurred to some Soviet flyers working on ice reconnaissance flights for the Northern Sea Route. I. I. Cherevichnyy, a pilot, and V. I. Akkuratov, his aptly named navigator, made two excursions towards it between their routine flights. One was in August 1939, the other in July 1940. They were long flights – one lasted twenty-two and a quarter hours – and the aircraft returned to its base after each. The flights convinced them that the 'Pole of Inaccessibility' region was not too difficult to reach by air, and

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that there would be enough possible landing-places on the ice for one to be fairly certain of being able to come down close to the spot one was aiming for.

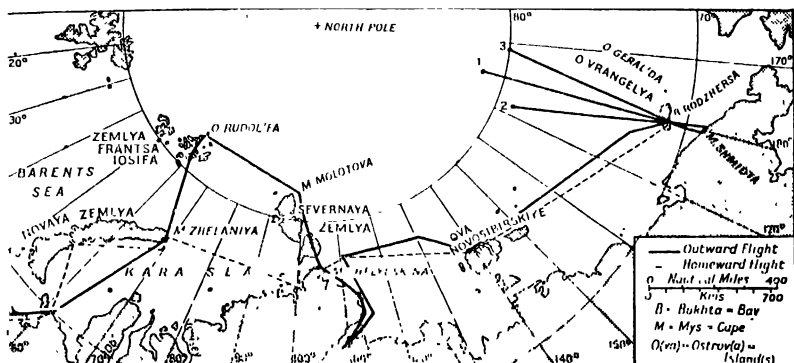
In December 1940 the suggestion of landing on the ice in the region was put up to the Arctic Institute at Leningrad by these two, and it immediately found warm support. A scientific programme was worked out, and the Chief Administration of the Northern Sea Route (Glavsevmorput), to which both the Institute and the flyers were responsible, approved the plan. Three landings on the ice were envisaged, with a stay of several days at each point. The party of scientists were to include M. Ye. Ostrekin, who was to do the magnetic and astronomical work, and N. T. Chernigovskiy, in charge of hydrological and actinometrical observations. The captain of the aircraft was Cherevichnyy, the navigator Akkuratov (who was also to be the meteorologist of the party), and there were a second pilot, radio operator, and three flight engineers. The chief scientist of the expedition and the senior man present (he was not termed the leader, however) was Ya. S. Libin, the Director of the Arctic Institute and a hydrologist. It seems that Libin was subsequently disgraced in some way, for some later narratives of the expedition carefully avoid any mention of his name. This sort of thing happens from time to time, but it is very difficult to find out what became of the person whose name is so scrupulously erased.

The aircraft, a Soviet four-engined ANT-6 called 'SSSR-N-169', had already seen much Arctic flying. It had been one of those used to establish Papanin and his three companions on their ice floe at the North Pole in 1937. It was thoroughly overhauled and got ready for the exacting flight it was about to do. Skis were fitted. Akkuratov paid special attention to the navigational equipment, which included a compass devised by him for the North Pole flights.

The expedition was expected to carry out ice reconnaissance both on the way out and as far as possible in the region of the main objective; so the outward flight, which took place in March 1941, was by way of the various island groups along the

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whole length of the Northern Sea Route – Novaya Zemlya, Zemlya Frantsa-Iosifa, Severnaya Zemlya, and Ostrova Novosibirskiye. Some of the areas flown over had never been observed in winter before; particularly the northern part of the Kara Sea and the East Siberian Sea, where important information about the state of the ice was in fact gathered. The flights were what could be described as 'uneventful', but there were one or two anxious moments for the navigator. The leg from Ostrov Rudol'fa to Mys Molotova had never been flown before. The



Map 2. The flight of the 'SSSR-N-169' to the Pole of Inaccessibility region in 1941.

radio beacons at Rudol'fa and at Mys Zhelaniya, at the northern tip of Novaya Zemlya, were to provide a reliable check on the aircraft's position for most of the way. But Rudol'fa went out of action almost as soon as the aircraft had taken off, and Zhelaniya was an hour and twenty minutes late in coming on the air. So Akkuratov fell back on dead reckoning. The pilots got worried because they thought the course was much too northerly. But Akkuratov stuck to his guns. He began to feel happier when the radio beacon at Mys Chelyuskina was unexpectedly received at extreme range, and not long after the northern part of Severnaya Zemlya came into view – only four minutes late.

On 21 March the aircraft reached Ostrov Vrangelya and landed on the sea-ice off the polar station, which was at Bukhta

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Rodzhera, on the south coast of the island. This was to be the main base of the expedition; but arrangements were made for facilities to be available also at Mys Shmidta, a larger polar station and settlement on the shore of the mainland opposite. An alternative landing-strip was required in case of bad weather.

Final preparations were now made for the first flight out to the 'Pole of Inaccessibility' region. The aircraft was loaded until it was considerably over weight; it was necessary to take fuel for both outward and return trip: and this was of course much the largest item. Ten men, including the crew, were to go. Besides their stores and equipment for a short period on the ice, reserve rations for two months were carried.

The aircraft took off successfully on the evening of 26 March. The overloading made it difficult to climb higher than 400 feet, but the planned cruising height of 650 feet was reached in thirty-five minutes. Another reason for this low altitude was the need to observe the ice in detail throughout the flight. However, before the island had been cleared – it was necessary to fly round rather than over it at this altitude – one engine developed a knock, and it was judged wisest to return. Landing with an overload of about three and a half tons was no easy job, but it was successfully done.

Bad weather prevented making another start for several days, and it was 2 April before they got away. After nearly seven hours flight they reached the area in which they intended to land: about 81° N. latitude and 180° longitude. (In fact this is about 250 miles away from Stefansson's 'Pole of Inaccessibility', but that did not matter much.) A suitable floe for landing on was sighted from the air, a smoke-bomb was dropped on to it, and a successful landing was made. The floe chosen was about a mile long and 450 yards wide, and less than a third of the total length was required for the landing. There was fairly thick snow cover, and the ice below was about six feet thick. All round there were floes of older, heavier ice with a surface corrugated by ridges and hummocks caused by pressure. Probably this particular floe had first frozen about eighteen months before, had grown steadily thicker throughout the

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winter, and owed its lack of pressure ridges to the protecting circle of heavier ice. The problem of selecting the right piece of ice from above is not particularly easy, and can be done only by a pilot with considerable experience of ice observation. He is guided by such features as the distribution of pressure ridges, the colour and appearance of the snow cover, and the dimensions of the blocks of ice in the hummocks. Sunshine helps him a great deal because unevennesses in the surface cast easily visible shadows. Normally selection should be possible from heights of up to nearly 1,000 feet.

Despite the solid appearance of the floe, there was no reason why it might not be cracked or broken up by pressure while the party were on it, so the aircraft was kept at thirty minutes readiness for flight and a careful watch of the surrounding floes was maintained. Even then, it was realized that the airstrip might well be rendered unusable in less than thirty minutes, so an alternative site about a mile and a half away was reconnoitred. This would have required ten days' work by everyone before it was suitable for a take-off, but fortunately there was no need to use it.

Five days were spent here, with the scientists busily engaged on their observations and members of the crew helping when they could. The hydrologists set about sounding, taking samples from the sea-bed, and measuring the temperature and chemical content of the sea-water at various depths. For sounding they had special light-weight and time-saving equipment. Papanin's North Pole party had found sounding a very strenuous business: hours on end were spent winding in the line. So Libin and Chernigovski had a winch fitted with a small 3-h.p. motor. The line was only 1.3 mm. thick, and there were 7,000 metres of it. Time and energy were also saved in making the hole in the ice through which the lines and bottles had to be lowered. Explosives were used for this: five or six pounds of ammonite were found to make a hole of just the right size. A tent was put over the hole, and a stove of the kind used for heating the aircraft engines before starting kept the temperature quite high inside – up to 68° F., while it was zero or 20° below

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outside. So there were no difficulties with apparatus freezing or men getting hands or brains numbed by cold. Some of the aircrew helped in this work when they could.

The magnetic and astronomical observations were made in the open, with the instruments sheltered by a wind-screen. The gravimetric work was done in a small unheated tent. Since only one man, Ostrekin, was available to do all this, he had a very busy time.

There was a living-tent in which three or four people were generally sleeping. This tent was also unheated (the amount of fuel and equipment that could be brought was cut to a minimum), but fur sleeping-bags were used.

Clothes and food were those in normal use at polar stations. Each man had a reindeer-fur suit, dog-fur top boots with felt soles, and in addition leather coat and trousers with a short fur overcoat. These are clothes for people who are going to live in and around a base hut and are not intending to walk very far. Nothing out of the ordinary was brought, designedly; because the party wanted to prove that an expedition like this could be put in the field with the least possible trouble.

Favourable weather reports allowed the flight back to Ostrov Vrangelya to be made on 7-8 April, with Mys Schmidta as an alternative landing-strip. The flight back was uneventful, except that cloud obscured the sky much of the time, rendering astronavigation impossible. In high latitudes a 'fix' on a star or the sun is the surest way of determining one's position. The magnetic compass becomes difficult to read, because the needle is either listless and points nowhere consistently, or 'hunts' from one side to the other of the correct direction; the gyro compass is also unsatisfactory; and radio beacons are generally out of range. So prolonged inability to see a heavenly body makes things difficult; but in this case the correct course was maintained and the aircraft landed safely on the ice at Bukhta Rodzhersa.

There was a stormy period after the return, so the second flight could not be made until 13 April. The landing-zone was reached uneventfully - it was about 180 miles south of the pre-

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vious one, on roughly the same meridian – but there was some difficulty in finding a suitable piece of ice to land on. The pilots searched for over half an hour before they found an area of level, comparatively young ice measuring 1,250 by 400 yards. They landed here, and work was at once started on the scientific programme. During the four-day stop a polar bear paid a visit to the camp. The party were mostly asleep and without weapons, but one man fetched a rifle from the aircraft and was about to shoot when Cherevichnyy, the pilot, shouted ‘Don’t shoot! I want to take a photograph.’ The photograph taken, the party (now all awake) discussed what to do with the bear. The majority were in favour of letting him go, although it was quite clear that he would continue to hang about the camp. So he was spared, and during the next few days was never far away, eating scraps of food and paying practically no attention to humans. His most unpleasant experience was licking the metal radio mast when the thermometer read -8° F. At this temperature flesh sticks to metal, and the bear left part of his tongue on the mast. After this he disappeared for some hours, but was back in time to watch the aircraft fly away. The presence of a polar bear in this remote region, 375 miles from the nearest land, was interesting, but not really very surprising. They have been found before at very great distances from land and it is well known that they spend long periods wandering about the ice of the Arctic Ocean in search of their food, most of which lives in the sea. The tracks of an arctic fox were also seen at this camp site.

It was planned to make the third landing to the north of the first by some eight-five miles, in the region of 83° N. latitude and 180° longitude. To fly the extra distance meant operating the aircraft at maximum range. A start was made on 22 April, after waiting for favourable weather. Ten-tenths cloud was encountered at latitude 74° N., and snow soon began to fall and visibility dropped to one to two miles at 300 feet. Quite apart from the need to fly low in order to observe the ice, the overloaded aircraft could not in fact climb much higher. A momentary glimpse of the sun enabled the position to be fixed at 80°

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N., 174° W. When the landing-zone was reached the aircraft was flying in dense fog and ice was forming on the wings and tailplane. There was no alternative but to turn back. It was decided to return to the area where the last sun-shot had been obtained, in the hope that there would still be rifts in the clouds there. The cloud cover was practically unbroken, however, so choice of a landing-place had to be made in the absence of sunlight. An apparently level floe was selected. It could be seen that there were no hummocks or ridges on it, but there did appear to be skavler – parallel wave-like ridges caused by wind action on a snow surface. When the aircraft touched down it was found that the skavler were a good deal more pronounced than had been thought, with the result that the landing was extremely rough and a ski of the undercarriage was damaged. This damage was fortunately repairable, but the damaged ski remained weak, and this meant that precious time had to be wasted by all in preparing a runway in order not to risk breakage on take-off.

The party remained at the third camp for five days. The round of scientific observations was completed, and on the evening of 28 April the aircraft took off – without damage – for Ostrov Vrangelya. The weather was good, and a slight detour was made to the east in a vain search for any signs of a mysterious island called Ostrov Krest'yanki, thought to lie in the region north of Ostrov Geral'da. On 5 May the expedition set off for home, the return course also lying wherever possible over the sea so that ice forecasters might derive the greatest benefit. Moscow was reached on 11 May. The expedition had lasted sixty-eight days and had flown a total of 15,000 miles, of which 12,000 were over the sea.

The scientific work that had been undertaken could not, in view of the shortness of the time actually spent on the ice, be of fundamental importance, but it nevertheless yielded some very interesting indications.

The only information up to this time about the depth of the ocean in these regions came, as mentioned earlier, from one echo-sounding made by Sir Hubert Wilkins in 1927. The depth

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registered was about 5,400 metres, and this was very considerably greater than any other depth measurement in the Arctic Ocean. The greatest depth recorded by the Russian party was 3,370 metres, measured with a line and winch rather than with echo apparatus. Admittedly Wilkins was about 150 miles on the Alaskan side of the stations occupied by the Russians, but even so it seems fairly conclusive that his measurement was wrong. The soundings made by the Russians indicate that the sea bottom slopes downwards in a north-easterly direction in this region; but it was their shallowest sounding – 1,856 metres – which was closest to the point of Wilkins's observation, so the likelihood of both being right is small. The new observations altered the general conception of the sea-bottom configuration in the Arctic Ocean. Hitherto it had been thought, on the basis of Wilkins's figure, that the deepest part of the ocean was in the region between Bering Strait and the Pole; but now it would seem that the greatest depths are almost at the opposite side, in the region north of Zemlya Frantsa-Iosifa (where the *Sedov* expedition had found no bottom at 5,180 metres).

The hydrologists were also interested in the layering of the water. Nansen had discovered, while he was drifting across the Arctic Ocean in the *Fram*, that there were three principal layers of water. That nearest the surface, called by him North Polar water, had temperatures below 32° F. and was comparatively fresh; this was due to the effect of the ice. Below that layer was another and broader one, with temperatures above 32° F. and higher salinity. This Nansen identified as water from the North Atlantic, brought in by the Gulf Stream and continuing across the Arctic Ocean beneath the surface. Below this again was the bottom current, which had rather higher salinity than the layer above, but was colder. The 'Pole of Inaccessibility' party were able to confirm Nansen's findings fully. The layer of warm Atlantic water was clearly there: rather narrower, with its warmest point rather deeper and its average temperatures rather lower than where Nansen observed it, which was much nearer the Atlantic. This narrowing and cooling of the layer as the water goes eastwards is confirmed by other observations in

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high latitudes, and it is what one would expect. On the other hand, it is still so considerable – 525–625 metres thick – that one may suppose it is to be found all over the Arctic Ocean. It is remarkable that the water of the Gulf Stream should be so clearly discernible here, at exactly the opposite side of the Arctic Ocean to that at which it entered and some 9,000 miles from its place of origin; but since its upper level is about 250–300 metres below the surface, it is doubtful if it exerts any influence on the weather or the sea-ice in the area.

Detailed notes were taken on the ice situations. These were mostly made in flight, of course, because the main immediate object of the expedition was ice reconnaissance of the regions flown over. But various investigations were also made on landing. One of the points the party was interested in was the age of the floes: was the ice in this region several years old, having been for some time up in the central part of the Arctic Ocean, where there is little melting in the summer; or was it only a year or so, having either formed on the spot or drifted up from the south? They found that old, 'polar' ice predominated only north of 76°, and at the places they landed there was not more than 80% polar ice. The difference in thickness between the two sorts was not tremendous: about ten feet for the old and six feet for the young. But there is a great difference in toughness and compactness, as a ship trying to battle with them soon finds out. There were quite large cracks and leads containing open water. This might surprise one at first, seeing that the region was within 600 miles of the North Pole and the season was still winter (April is the last month of winter in the high Arctic); but where there is much ice movement there is always open water. Obviously it was in last year's patches of open water that the one-year-old ice had formed. All this information was of great interest to the experts in Leningrad who were trying to form a general idea of the circulation of Arctic ice so that ships' movements could be planned more effectively.

It was established that the ice drifted in a westerly direction in this part of the Arctic Ocean at the rate of one and a half sea miles a day. Further to the west, Nansen and the *Sedov* had

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found such a current and had drifted along in it for two years. But it was interesting to find evidence of it as far to the east as this. Below the surface the layer of Atlantic water was found to be going in the opposite direction at about one sea mile a day; and the bottom current was going westwards, like the surface water, but at only half a sea mile a day.

Although the ice was moving in this general direction, the floes the party were camping on did not drift steadily westwards. For the wind acted on the ice, and drove it in all sorts of directions and often at much faster speeds. But the winds were more often in that direction than any other. By calculation it was found that if the wind were left quite out of consideration and its effect eliminated, there was still a westerly current, which had nothing to do with wind action, running at about half a sea mile a day on the surface. It ran nearly five times as fast as this twenty-five metres down, but the weight of ice slowed up the current. Nansen had put forward this idea, too, but the expedition's findings were useful confirmation.

Meteorological observations were made regularly, but as the party was on the ice such a short time it is not possible to draw any conclusions as to the climate of that part of the world.

There was no marine biologist in the group, but plankton was collected at one of the stations and analysed when the expedition returned. Examination showed that there was nothing very exciting about it: there were no species which had not already been identified in samples taken elsewhere in the Arctic Ocean or North Atlantic. No link with the North Pacific could be proved, for instance, by the presence of species hitherto found only there.

The magnetic observations also tended to confirm earlier hypotheses: they provided more evidence for the fact that there is a centre of attraction – rather grandiloquently called a ‘second magnetic pole’ – in the Soviet sector of the Arctic. The north magnetic pole itself, towards which magnetic compasses tend to point (when not in the Arctic) has long been known to be in the region of the Canadian Arctic islands. The magnetic

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field in the central Arctic thus seemed to be symmetrical. But this theory was later discountenanced.

The success of this particular method of mounting an expedition is itself a valuable result – probably the most valuable. The only other ways tried up to that time of reaching remote parts of the Arctic Ocean were either by permitting a ship to get frozen in and then drift across (as the *Sedov* or the *Fram*), or to land a party and leave it there for a considerable time (as Papanin's North Pole station). The advantages of the new technique are quite obvious: it is cheaper, it makes the organization easier, and there is greater freedom of choice in the points to be investigated. There is particular advantage to hydrological studies, because the necessary equipment can be carried without too much difficulty by aircraft, and certain hydrological observations such as soundings, temperatures, and salinity measurements can be valuable even if made for only a short period of time. But it is clearly not satisfactory in cases where heavy equipment is needed, or in order to make observations of a sort which are valuable only over a long period – such as collection of meteorological data. Libin, the chief scientist of the expedition, looked forward to a time when three or four aircraft, based at different points, would make a large number of landings on the ice each spring in order to provide the necessary information for ice forecasters. This would suit this sort of work because the information required at each point of observation is small and could be obtained in a matter of hours.

We shall see in the next chapter the extent to which the technique has in fact been used by the Russians since 1941. The Americans have found it useful too. Aircraft of both the US Navy and the US Air Force have landed on the ice of the Beaufort Sea and Arctic Ocean north of the Canadian Arctic islands, and have measured the depth of the sea. A series of flights in 1951 and 1952 called 'Project Ski-Jump' is one example.

Cherevichnyy's expedition relied exclusively on aircraft. In this it was something of a turning point in expedition tech-

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nique. It was not just a notable polar flight – there had been many such – but it was a development in technique for which the Russians deserve every credit. It was to be expected, perhaps, because they have always made the fullest use of aircraft. The aeroplane is in many ways so excellently suited to the Arctic that it is not in the least surprising that they have done so. It alone can cross quickly and easily hundreds of miles of trackless wilderness; it alone can make a rapid survey of the ice which is lying in the track of ships; and it alone can bring food, or a doctor, or what you will, to an isolated outpost in a matter of hours. The twentieth-century advance into the Arctic owes more to the aeroplane than to any other single factor; and this is as good a place as any to sketch in the Russian contribution.

The Russians can genuinely claim that they were the first to use aircraft in the Arctic. Lieutenant Nagurskiy of the Imperial Army made five flights in the summer of 1914 over the Barents Sea and Novaya Zemlya. (Others had taken aeroplanes to the polar regions before this, but none of them had actually flown.) With a Farman seaplane, powered by a 70-horsepower Renault motor, Nagurskiy was helping the expedition out looking for Lieutenant Georgiy Sedov's party, last heard of two years before. The flights were successful, not in helping to find Sedov's men, who returned in their own ship shortly afterwards, but because they showed the tremendous potentialities of the aeroplane. But his example could not be quickly followed. 1914 disrupted most things, polar aviation among them. Nagurskiy himself left immediately for the front.

In fact it was ten years before the experiment was repeated. In 1924 a Junkers piloted by Chukhnovskiy helped to select the best route across the Kara Sea for the ships bound for the Ob' and Yenisey. And from that time the aeroplane was increasingly used, until in a few years it had established itself and had become absolutely essential. Its subsequent history could be told in terms of the remarkable and often spectacular flights that were made; but to do this would be to obscure the real importance of the Soviet contribution, which is not spectacular.

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In the 1930's the organization of Arctic flying was worked out in greater detail. A clear distinction was made between freight and reconnaissance flights. The normal freight and passenger routes ran mostly down the river valleys and ended at the Arctic coast. Something is said about these elsewhere. There was a quite separate organization for weather and ice reconnaissance flights. Not many aircraft were employed – the greatest number before the Soviet Union entered the war was in 1940, when there were twenty-four – but they flew over all the shipping routes at frequent intervals. As resources increased and organization improved, the area covered by regular flights was enlarged to the north, so that the forecasters could get some idea of what the ice was doing up in the Arctic Ocean. An equally important expansion of the service was the introduction of winter flights; these were no direct use to ships, of course, but they were vital to the forecasters. By 1955 the ice patrols were flying over three quarters of a million miles a year in nearly 5,500 hours of flight and using 22 aircraft.

The old system of assigning an aircraft to each convoy of ships was abandoned after 1936. There was thought to be no longer any point in using aircraft as guides in this way, because the whole of the route the ships would take, and a great deal else too, was being regularly flown over.

All this could never have been done, of course, without a corresponding improvement in the technique of Arctic flying. This is where the spectacular and record-breaking flights played their part: S. V. Obruchev's aerial expedition to north-eastern Siberia in 1928; Krasinskiy and Kal'vits's flight from Bering Strait to the Lena in 1929; the flights leading up to the establishment of Papanin and his party at the North Pole in 1937; the trans-Arctic flights of Chkalov and Gromov to the United States via the Pole in the same year; the search for Levanevskiy, who was lost trying to do the same thing; Cherevichnyy's flights in 1941; the ice reconnaissance flights to the far north in the last years of the war, including Titlov's to the Pole in 1945. The real importance of all these to Arctic aviation was their contribution – which was not small – to improving navigation methods and

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solving the countless technical problems of flying long distances in high latitudes.

The headline-making flights of 1937 are the only ones which have attracted much attention abroad, so it is by them that Soviet Arctic flying is generally judged. And indeed, on this showing the Russians would rate high; no one else had done anything so striking with such success before the war. But these exciting events were of course only a very small part of the country's effort. It is in fulfilling the solid routine of carrying passengers and reporting the weather and the ice that the Soviet Union has a pre-eminence which really counts. In this, the Americans and Canadians have reached today the stage the Russians reached in about 1943.

The aircraft the Russians use vary widely. Seaplanes, flying-boats, land aircraft with wheels or skis are all common. The seaplanes and flying-boats are used for summer ice reconnaissance, when there is plenty of open water about. The wheel or ski undercarriage – of the two, wheels are preferred for most occasions – is used in winter and for all normal overland flying. The favourite aircraft is the American C-47 or Dakota, which the Russians began to get during the war. It is interesting to note that no Soviet-built aircraft – not even the PS-84, which was similar to a Dakota – was thought to be so well suited to the purposes of Arctic flying. No less than three different flying-boats had been specially designed and built for ice reconnaissance, but in one way or another all had been unsatisfactory. Probably there never will be a specially designed aircraft, because, after all, the demand is very small.

Airfields are not numerous. The regular passenger routes are reasonably equipped, but some of the bases from which the ice reconnaissance flights operate were still primitive at the end of the war. There was no prospect of quick improvement – the cost of building the required number of modern airfields would be vast – although there were several incentives to provide something better. One was the desire to standardize on one type of aircraft, which would mean using land aircraft all the year round; seaplanes and flying-boats were retained, in fact,

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largely because they created no difficulties over landing-strips. In the last year or two there has been more construction, without doubt. Presumably there is a Soviet counterpart to the American base at Thule in north-west Greenland; somewhere in Zemlya Frantsa-Iosifa is the likeliest place – perhaps Ostrov Rudol'fa, which has been used by aircraft since 1936.

The technique of landing on ice is one at which the Russians excel. The brilliant landings at the North Pole in 1937 are well known, but this was not the beginning. Back in 1926 the Soviet pilot Babushkin landed several times on the ice of the White Sea while he was locating colonies of seals. And later, of course, with the further experience of Cherevichnyy's landings it became commonplace. The textbooks even lay it down that any level stretch of sea ice more than one foot four inches thick will bear the weight of a twin-engined aircraft.

CHAPTER THREE

High Latitude Air Expeditions and Drifting Stations

The 'Pole of Inaccessibility' expedition was certainly a turning point, for it has set in train a series of the most imaginatively planned investigations that the Arctic has perhaps ever seen. There was a delay, of course, in following up the idea, because of the war (in which the Soviet Union became involved a few weeks after Cherevichnyy's aircraft had got back to Moscow). It was in 1948 that the next start was made, when the first 'high-latitude air expedition' left for the Arctic.

The pattern of the high-latitude air expedition was simply Cherevichnyy's plan on a larger scale, and almost exactly as Libin had envisaged. Several aircraft were used, and they landed parties at a series of points on the floating ice of the Arctic Ocean during a period of six weeks or so in the spring. Lightweight and portable equipment was developed specially for the job. The routine of making oceanographical, magnetic, and meteorological observations was carefully worked out so that in the end only a few hours were required at each stopping place. There are no detailed accounts of the early high-latitude air expeditions (they have taken place every year since 1948 with the possible exceptions of the seasons 1951-53), but many landings were made. The map shows how they were distributed. In some years, it will be noticed, stations quite close to the Canadian islands and Alaska were occupied.

In 1950, however, a more audacious plan was added to this already striking concept. Thirteen years earlier the Soviet Union had astonished the world with her successful flights to

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the North Pole and the establishment there of the North Pole Drifting Station. This was a quartet of observers led by Ivan Papanin, and they remained on their ice-floe until taken off by an icebreaker nine months later, by which time they were off Scoresbysund on the East Greenland coast. This spectacular method of obtaining scientific data from inaccessible oceanic regions was only made possible by radio; for the party left to drift had no means of getting to land by itself – it relied entirely on signalling its position and being picked up. A piece of ice is a very good platform from which to study the sea beneath; for one thing, it is so much more stable than a ship. So why not continue Papanin's method? There would be little difficulty about landing the party, after the experience gained by the pilots of the air expeditions in landing on unprepared floes. Many of the scientific observations would supplement those of the air expeditions, of course; but the longer period spent on the floe would also allow different sorts of observations to be made. Of these, the actual course of drift would be one of the most valuable, because it should lead to elucidation of the whole system of water and ice circulation in the polar basin.

So, in the spring of 1950 a party of sixteen, led by M. M. Somov of the Arctic Institute, was deposited on the ice at latitude $76^{\circ} 02' N.$, longitude $166^{\circ} 30' W.$, or about 300 miles north-east of Ostrov Vrangelya. The floe had been selected from one of the aircraft of that year's air expedition, on which had been placed responsibility for establishing the station. The floe was ten feet thick, seemed well able to withstand the pressure that the winter would bring, and had a large expanse of level ice close by which could act as an airstrip. The advance party had come in at the end of March, and in a few days the whole group and its equipment and stores had been flown in. The expedition started work.

The meteorological observations, at once radioed to land, were the contributions of the greatest practical importance. The station was so isolated that its weather reports were bound to fill in a big gap on the synoptic charts of the forecasters. The oceanographical studies were no less important, although there

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was not the same immediate return. The ice work included, as already mentioned, the computation of drift from the course taken by the floe, but it covered much more than that: structure, physical and mechanical properties, temperature regime. And finally, geomagnetic, gravity and aurora observations were taken.

In the summer working conditions were often bad. The snow lying on the ice melted, and big puddles formed, many a foot or two deep. This made movement about the camp difficult. But it was always possible, as soon as a reasonable amount of water had collected, to bore a hole through the bottom of the puddle and drain the water out, like emptying a bath. The winter, however, brought much greater discomforts. To the intense cold was added total darkness, and in addition the very real danger that pressure in the ice would cause the floe to crack. This in fact happened several times. Cracks passed underneath some of the tents, necessitating hurried transfer to another floe. This was far from easy in storm and darkness. But all emerged safe at the end of the winter.

Communication with the mainland was always maintained by radio. Flights were made fairly frequently, including four when winter was already arriving. Some members of the expedition returned in these aircraft, leaving a wintering party of eleven.

In April 1951 the floe had reached lat. $81^{\circ} 45'$ N. and longitude $162^{\circ} 20'$ W. Here, on the 10th, the party were collected again by air. They took back with them a year's very valuable observations from one of the least known parts of the earth's surface. But, curiously enough, that was not the last that was seen of the camp site they had occupied. The collection of black huts and tents was seen from the air some months later, and then, three years after its abandonment, it was found again not very far from the position it was in when the camp was first established in 1950. In four years, therefore, it had presumably described an almost complete circle. An aircraft landed by the deserted camp in 1954, and a member of the original wintering party inspected it. The most remarkable change was the fact

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that the tents were now standing on pillars of ice four or five feet high. This was most interesting; for it showed in the clearest way that the floating ice in this area had been melting on the top side, and therefore presumably growing on the under side (because the thickness was the same as before). The whole mass of ice in fact was gradually moving upwards, and the pillars under the tents were there because the tents had prevented the ice directly beneath them from melting.

The results achieved by this drifting station fill four volumes. (Only three have been allowed to leave the country; the fourth contains the gravity measurements, which are regarded as secret by the Soviet Government.) The figures themselves are not generally especially exciting, most of the interest lying in there being any measurements at all of various geophysical phenomena in this quite unknown region. But they did emphatically whet the appetite for more. It had been demonstrated effectively that a station of this sort could be established, supplied, and evacuated by air without any great difficulty – thanks largely to the remarkable know-how of Soviet Arctic air crews. In 1954 therefore a further development of the idea was planned.

The high-latitude air expedition of that year was to be a big one, and it was proposed that the aircraft should set up two drifting stations at selected points. It was a definite part of the intention also that these stations should not be for one year only, but should be re-staffed annually, or, if it was necessary to close one because it had drifted into the wrong position, another should be set up. Continuity was therefore a prime object. It was at this stage that the stations got a name – *Severnnyy Polyus*, meaning 'North Pole' in Russian, which was abbreviated to SP. Papanin's party was retrospectively christened SP-1, Somov's SP-2, and the two about to be established SP-3 and SP-4. A rather curious feature is that it was only when SP-3 and SP-4 were set up in 1954 that the first news was released about SP-2 and about the early high latitude air expeditions (Papanin's SP-1 had been surrounded by a blaze of publicity throughout). Why all this should have been kept secret

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for up to six years is not at all clear; but presumably Stalin's death had something to do with the reversal of the policy.

The stores and equipment for the new stations were to be on a larger scale than those for SP-2. The number of winterers was to be increased from eleven to between twenty and thirty. SP-2's proudest possession was a car; the new stations were to have a helicopter as well. SP-3 even got a piano included in its stores list. The whole operation of setting up the stations and running the air expedition was directed personally by the head of the Northern Sea Route Administration, V. F. Burkhanov.

The aircraft were divided into three groups. The first, led by Cherevichnyy, was based on airfields at Ostrov Diksona and in Zemlya Frantsa-Iosifa. Its job was to take the usual parties from place to place in the central Arctic area. Distances being great, some intermediate airstrips were established on the ice, so that aircraft could refuel there when necessary. Cherevichnyy's group thus had the main responsibility for the air expedition proper. Ostrekin, another member of the 1941 party, was in charge of the scientific work of the men working on the ice. The second group, under the experienced polar flyer I. S. Kotov, occupied airfields at Ostrov Diksona and further east at Mys Chelyuskina and on Severnaya Zemlya. Its main task was to establish SP-3. The third group, with M. A. Titlov in charge (he had made a name for himself with his flight to the North Pole in 1945), was to work from airfields further east again – Mys Shmidta and others – and establish SP-4.

Outside the three groups were several independent detachments. The so-called 'flying observatory' was an aircraft detailed to fly to any region required and collect weather information, under the direction of I. M. Dolgin, an Arctic Institute meteorologist. Another mobile group headed by an Arctic Institute ice specialist, P. A. Gordiyenko, made observations of ice conditions from the point of view of estimating suitability for airstrips. There was a bigger group of ice specialists, also from the Arctic Institute, engaged in more general studies of the physical properties of floating ice.

The weather was exceptionally warm in the Soviet Arctic

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that spring, and this meant difficult flying conditions, with fog and low cloud. However, by early April all groups were in position at their Arctic bases, and the personnel and equipment of the drifting-stations were with them. The leaders of the two stations, A. F. Treshnikov for SP-3 and Ye. I. Tolstikov for SP-4, flew with their group aircraft in search of strong-looking floes on which to set up their camps. The site for SP-3 was found on 9 April about 250 miles from the North Pole on the Bering Strait side at latitude $86^{\circ} 00' \text{ N.}$, longitude $175^{\circ} 45' \text{ W.}$ The floe was tough and old, but the nearest flat expanse where an aircraft could land was five miles away. This was a disadvantage, but not an insuperable one. The station was fully established and operating by 15 May, regular weather observations having started a month earlier. Tolstikov found a place for SP-4 on 8 April. It was between the location for SP-3 and Ostrov Vrangelya, at latitude $75^{\circ} 48' \text{ N.}$, longitude $178^{\circ} 25' \text{ W.}$ The same process of flying in men and stores and building the camp went on here.

Each station received its helicopter, which flew up from the mainland, using intermediate bases laid down on the ice to make up for lack of range. A tractor as well as a car was provided. The tractor could be used as a bull-dozer, and was therefore vital in clearing airstrips. The car ferried men and goods locally round the camp. The piano was a tremendous success, with V. G. Volovich, Treshnikov's doctor, the life and soul of many a party. The living and working accommodation consisted partly of the standard Soviet dome-shaped tents, and partly of huts designed by an equipment specialist named Shaposhnikov, made of light sections easily transportable by air and mounted on sledge runners. Heating was chiefly by coal stoves, cooking by bottle gas, and lighting by electricity (produced by wind generator). Contact with the mainland was more regular and more frequent than in the case of SP-2, aircraft flying in monthly with fresh food, mail, and other stores. The winter flights were sometimes most difficult and dangerous, but apparently no planes were lost.

The scientific work covered the same broad topics as had the

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SP-2 programme, with the emphasis on meteorology, oceanography, geomagnetism, and ice studies. There were notable improvements in instrument design; and the helicopters permitted observations to be made aside from the line of drift – anywhere within a radius of eighty miles or so. The regular air service allowed specialists who were not members of the expedition to come out for short periods in order to do particular pieces of research. This opportunity was made considerable use of, and although the coming and going must have been distracting and inconvenient to the regulars, some useful work resulted.

Apart from the difficulties and discomforts one would expect at such close proximity to the Pole, the greatest danger was that of the floe breaking up. The danger was ever-present, because pressure might begin at any time, brought about by forces acting on the ice possibly a great distance away. The reader who has followed the drift of the *Sedov* will know about all this. Treshnikov reports that at SP-3 on 24 November 1954

‘a crack in the ice passed through the camp. Most of the men were asleep and only the man on watch heard the noise. Suddenly a blow was felt and the floe shuddered. Everyone woke up quickly and ran out of the tents. All went to pre-arranged places for ‘ice alarm’. The crack passed between the tents of the meteorologists and started visibly opening. It passed beneath the tent housing the magnetic instruments. The edge of the tent hung over the water, but tent and equipment were saved. In ten to fifteen minutes the floes had parted and there was open water 50 m. wide between them.’

This sort of thing was not a rare occurrence. Several times during the winter the camp had to be moved. But Treshnikov, a burly, jovial man in his late thirties, was temperamentally well suited to deal with situations like this. That was the impression he made when he came to Cambridge the following year as the guest of the Scott Polar Research Institute, and the quotation above is from the lecture he gave there (with the present writer

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interpreting for him). Tolstikov at SP-4 experienced similar dangers; the most extreme being occasions in summer storms when his floe, much reduced in size, seemed to its occupants to be alone in open ocean, with no other floes in sight.

Yet the year was completed successfully at both stations. In the spring the aircraft of the high-latitude air expedition returned, with instructions to carry out the relief. SP-3 had drifted across the Pole towards Greenland. It was in all probability about to be drawn into the Greenland current, which is what happened to Papanin's SP-1, and since the floe was known to be in poor shape after the winter's buffetings, evacuation was thought the proper course. This was done on 20 April 1955, but not without difficulty, for the nearest suitable airstrip was twenty-five miles away. The helicopter was vital here. SP-4 had plenty of room in front of it, and appeared to be following the 'closed circulation', the presence of which had been demonstrated by the re-discovery of the SP-2 camp. So it was necessary only to bring in a relief team. This was carried out without hitch between 5 and 17 April, the new leader being Gordiyenko, who had been in charge of the special ice group the previous year. Meanwhile SP-5, the new station to replace SP-3, was being put in. The chosen region, midway between the Ostrova Novosibirskiye and the Pole, was examined from the air, and on 16 April the leader, N. A. Volkov, alighted on the floe he had selected at latitude $82^{\circ} 11' \text{ N.}$, longitude $156^{\circ} 13' \text{ E.}$ A few days later the station was set up and the full programme was under way.

The same pattern of organizing the annual relief was continued each spring. In 1956 SP-4 and SP-5 were both allowed to continue; but since SP-5 was likely to reach an unsuitable position north of Zemlya Frantsa-Iosifa and require to be evacuated by the autumn, a third station, SP-6, was set up. This was placed on an 'ice island' – a piece of ice much thicker than normal sea ice. Since the war much has been written in North America about these ice islands of the Arctic Ocean. They originate by breaking off the ice shelves attached to the north coast of Greenland and Ellesmere Island, and then drift round in the

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Arctic Ocean, some possibly for hundreds of years. The Americans established a camp on a particularly big one, which they christened T-3, and manned it on and off for several years while it drifted round in the 'closed circulation'. The one selected for SP-6 was considerably smaller both in area and thickness, but it would appear to be of similar origin. It was about 200 miles north of Ostrov Vrangelya when it was occupied, at latitude $74^{\circ} 24' N.$, longitude $177^{\circ} 03' W.$ No Soviet party had occupied an ice island before (the American investigations on T-3 are one of the rare examples of beating the Russians to it in Arctic research).

In the autumn SP-5 was evacuated, as expected, leaving the two stations SP-4 and SP-6 in action through the winter. And then in the spring of 1957 SP-4 was closed on reaching the neighbourhood of north-east Greenland, having been manned continuously for three years. It had passed within eight miles of the Pole the preceding summer – closer than either SP-1 or SP-3. SP-6 was provided with a relief crew; and SP-7 was set up not very far from the spot where SP-3 began three years earlier, the intention being that it should follow the same general course as SP-3 and provide the opportunity to compare observations. SP-6 and SP-7 form part of the Soviet contribution to the International Geophysical Year. The scale of the supporting effort did not diminish. The 1956 air expedition and relief parties employed between thirty and thirty-five aircraft.

The vast accumulation of observations collected by all these parties is still being worked up in the Arctic Institute. Priority is being given to it because of the widespread interest, but few detailed results have actually reached print yet. A number of shorter papers have, however, and they are enough to show the general outline of what has been discovered.

One of the most interesting findings concerns the relief of the sea bottom. Very little indeed was known about this, so in a sense whatever was found was going to be interesting. But there is a special interest in what they found, because it confirmed earlier predictions. Working from data on tides in the Arctic Ocean, Rollin Harris in 1911 questioned the existence of

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one large deep-water basin covering the whole area, and Jonas Fjeldstad, also using tidal figures, surmised in 1936 that there was likely to be a submarine ridge or plateau extending from Siberia to the Canadian islands. And in 1953 L. V. Worthington, an American oceanographer who had taken part in the 'Project Ski-jump' parties of 1951 and 1952, concluded from the water samples he obtained that the temperature differences must be due to the division of the central polar basin into two parts by a submarine ridge running from Ellesmere Island to the Ostrova Novosibirskiye. And this is precisely what the Russians found. Their first suspicions were aroused in 1948 by the results of the air expedition of that year (but neither the results, nor even a hint that the expedition had happened, were published before 1954; so Worthington's prediction was still a prediction). They were confirmed by the subsequent work. The Russians called this submarine feature the Lomonosov ridge, after the remarkable Russian scientist, poet, and grammarian of the eighteenth century. Further investigations have apparently shown a number of other, lesser, ridges, mostly at right angles, which are believed to be older than the mesozoic Lomonosov ridge. The geological history of the region is being actively studied on the basis of the sea-bed samples brought up by the coring apparatus. The top section of these cores consists of ooze, largely made up of the remains of marine organisms, which has accumulated since the last great upheaval of this part of the earth's crust. By the layers distinguishable in this ooze it is possible to deduce facts about past climates. In this case it has been possible to show, for instance, that the inflow of warm Atlantic water into the polar basin stopped on three occasions in the last 50,000 years. This links up with the major climatic changes of the period, associated with ice ages.

Ideas about the circulation of water in the Arctic Ocean have been made more exact by the oceanographers' current measurements. Few detailed results have been published, but we know that special attention has been paid to the movements of the Atlantic water – obviously one of the keys to the whole situation. An interesting fact reported in this connexion is that the

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average temperature of the Atlantic water has gone up in recent years. The difference between the *Sedov's* observations in 1938 and those of the drifting stations in 1954–56 was 1.4°F . This has special interest, because the period of warming in the Arctic, which was particularly marked in the 1920's and 1930's, is thought by many to be stopping.

There has been a notable advance in ice studies. The course of the drifts has obviously thrown much light on the movement of the floes. Not only has the general pattern been confirmed: an anti-clockwise circulation on the Atlantic side of the Lomonosov ridge, and a clockwise on the Pacific side; but much has been learnt about the variation from year to year in the speed and dimensions of the circulations, and about the factors controlling these. There has been confirmation, too, of the 'rejuvenation' of sea-ice by its freezing on the under surface and melting on the upper. This affects the concept of age of floes. A floe may have existed for many decades, and yet no ice in it may be more than five years old. It follows that thickness is no guide to age. There have been many detailed studies of particular aspects of sea-ice behaviour, but again the results are not yet published.

The magnetic observations have been of practical use for navigation. They have also disposed of the 'second magnetic pole' hypothesis advanced in the USSR after the 1941 expedition. The position of the magnetic meridians as now plotted makes it clear how a second pole could have been thought to exist: the meridians do come together in the Severnaya Zemlya region, but they do not meet there, but, keeping parallel to each other and not far apart, cross the polar basin to the real magnetic pole.

Through these boldly conceived expeditions, the Russians have made themselves the undisputed experts on the whole central Arctic region. And the process of investigation is still going on. The whole effort shows up Soviet polar endeavour in the best light. Lavish logistic resources are used competently. The scientific programme is intelligently devised and on a continuing basis. The observers are of high quality, some leaders

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in their own scientific fields, and often of great experience (it is noteworthy that each relief crew has contained several members of earlier drifting parties).

If all the results are made freely available, as is the stated intention, then a very real contribution will have been made to geographical knowledge.

CHAPTER FOUR

The Voyage of the German Raider *Komet*

The *Hamburger Fremdenblatt* for 3 April 1943 broke to the public the astonishing story of the German auxiliary cruiser *Komet*, which had traversed the North-east Passage three years earlier with the help of Russian icebreakers. At the time, of course, the news did not cause much of a sensation, and was not reported in Britain at all. But it was a most unusual event. The last foreign ship to have made the passage was Roald Amundsen's *Maud*, which passed seven successive winters in those waters, from 1918 to 1925. Captain Robert Eyssen of the *Komet* broke even the Russian record by making the voyage from the Atlantic to the Pacific in twenty-one and a half days, of which only fourteen days were spent actually under way.

How did this come about? Since the end of the war it has been possible to piece the story together from captured German naval archives and from the account which Eyssen himself has written. After the signature of the Russo-German Pact of August 1939, the German naval High Command turned its attention to the north coast of the Soviet Union. At first it was interested in trying to obtain a naval base in the Barents Sea region, somewhere near Murmansk. But this fell through, partly because of the difficulty of keeping the affair secret, especially with British freighters in and out of Murmansk. The Russians, however, seemed to the Germans to be willing to co-operate, so inquiries were made about the use of the Northern Sea Route by German ships. The response was good. Captain von Baumbach, the naval attaché in Moscow, concluded negotiations for the passage of a German vessel.

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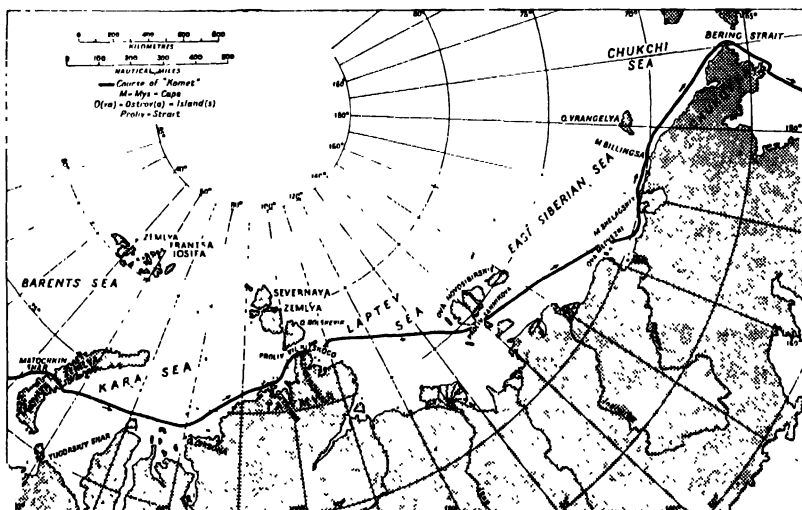
The ship chosen was known in German naval circles as *Schiff 45*. She was formerly the motor-ship *Ems*, of 3,287 gross registered tons and a maximum speed of fourteen knots. The cargo-holds were largely turned over to fuel storage, so that she had a range of 50,000 miles, or more than twice round the world. After conversion to the role of raider she carried six six-inch guns and five torpedo tubes. For this voyage the hull was strengthened and the steering gear given special testing, but no other unusual precautions were taken. The name *Komet* was given to her, but she never appeared in public under this name, since she was always disguised. Eyssen, the captain, had had experience of Arctic navigation aboard the survey vessel *Meteor* in the 1930's.

It might be argued that the Northern Sea Route is part of the high seas, outside territorial waters, and that therefore 'permission' to use it is not necessary. Legally, this point of view could certainly be sustained (although one or two key straits are, in fact, entirely within territorial waters). But in practice the navigational hazards of ice, fog, and poor charting are great, the Russians alone have the equipment necessary to overcome them, and so Russian assistance is very necessary. The agreement concluded provided for pilotage, icebreaker assistance, and weather and ice reports. The fee charged for this was about £80,000. There are no other similar cases, before or since, to provide comparison; but it would be exceedingly interesting to know whether this sum really represents calculation of the costs of passing one vessel along the route, with a fair proportion for overheads, or whether the Russians were simply charging what they thought the market would stand (knowing that money was no object).

On 3 July 1940 the *Komet* left Gdynia on the Polish coast, flying the Soviet flag. Proceeding by way of Bergen, where she spent a few days, she made for the Barents Sea. She was to meet the Soviet escort on 15 July at the entrance to Yugorskiy Shar, the most southerly of the three straits leading into the Barents Sea. But meanwhile von Baumbach had been in touch with the Soviet naval authorities, who told him the ice situation

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was bad. So the signal went out to the *Komet* that Yugorskiy Shar would not be open until at least 1 August, and that meanwhile the ship must wait in the open sea. This waiting was very trying. Position had to be frequently changed in order to lessen chances of detection by the British. The 1st of August came and went without any new orders being received. Eyssen was growing suspicious that the Russians were going to go back on their word, and his suspicions increased when he



Map 4. The voyage of the German raider *Komet* in 1940.

started intercepting radio messages which showed that convoys were already leaving Murmansk for the Northern Sea Route. But there was nothing he could do. It was out of the question to go forward on his own. So he continued to wait, until finally, on 13 August, he received a message directing him to proceed at once to Matochkin Shar, the fiord-like strait which divides the island of Novaya Zemlya in two, where the Soviet icebreaker *Lenin* was awaiting him. Aboard the *Lenin* would be M. I. Shevelev, the director of operations for the western sector.

Next morning *Komet* was at the rendezvous, but there was

no sign of the *Lenin*. Eyssen entered the strait, and about three miles down found a small settlement. A motor-boat put out from here, and two Russian pilots came aboard. The *Lenin* had left them there, they explained, about a week before, and they were giving up hope of ever meeting *Komet*. But now they were aboard, Eyssen at once pushed on eastwards. He entered the Kara Sea that same afternoon, covered 160 miles, and then encountered ice. A message from the *Lenin* had warned him of the presence of this ice, but he was anxious to make up for lost time. He investigated the ice edge for four hours in search of a lead, but decided he must do as the Russians said, and return to the eastern end of Matochkin Shar. The real difficulty was that fog had stopped ice reconnaissance flights, so that a clear picture of the situation could not be obtained. Icebreaker escort seemed essential, but the *Lenin* was busy in the eastern part of the sea, and would then have to bunker before coming to help. So another period of waiting began, but boredom could be somewhat relieved by sending parties ashore. The pilots, it seems, were very anxious about this unauthorized action; but needless to say, not a sign of human activity was to be seen on land.

This time the wait was not for long. Three days later, on 19 August, Shevelev permitted *Komet* to proceed again. There would be ice, he said, but it should not cause much trouble, and if it did, the *Lenin* was available to help. In the event, *Komet* met the ice – the same belt as before – about 200 miles out; and this time it was rotted by thawing to such an extent that the ship could get through unaided. He pushed on, making for Ostrov Tyrtova, one of a large number of small islands lying off the west coast of Taymyr, where the next stop was to be made.

Taymyr is the most northerly extension of the Eurasian land-mass, and the cape at its northern tip, Mys Chelyuskina, is therefore the most northerly point on the whole Northern Sea Route, lying in latitude 77° 43' N. For this reason, difficulty might be expected here. But there is another disadvantage: twenty-five miles north of the cape there is more land – the island group of Severnaya Zemlya. Into the strait, therefore,

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are frequently jammed masses of ice from either the Kara Sea to the west or the Laptev Sea to the east. So it is small wonder that this strait, Proliv Vil'kitskogo, has the reputation of being one of the most difficult stretches of the route. And it was in anticipation of difficulty there that Shevelev ordered *Komet* to wait at Ostrov Tyrtova.

She was at anchor for three days (22–25 August), and then the *Lenin*, which had been at Ostrov Diksona, the control centre for the western sector, appeared and instructed *Komet* to follow her. Early next morning they rounded the cape, with the strait entirely free of ice! Visibility was so good that the coast of Ostrov Bol'shevik, the most southerly island of Severnaya Zemlya was clearly visible from the ship. This also is most unusual, for fog is the other frequently occurring natural hazard – in August at Mys Chelyuskina there are an average of twenty-five days with fog; and it was this that prevented discovery until 1913 of Severnaya Zemlya, the last land-mass of comparable size to be discovered in the Arctic. So no wonder Eyssen described it as 'a wonderful trip through the strait. . . . Blue sky, a half moon, midnight sun – everything was there except the ice.' But the ice was waiting for them just round the corner.

At the eastern end of the strait the two ships were met by the icebreaker *Stalin*, the most powerful then afloat, as the reader will remember. Belousov, her well-known captain (his fame can be judged by the fact that there is now a Soviet icebreaker named after him), invited the captains of the *Lenin* and the *Komet* aboard for a conference. They discussed the ice, which was known to be a short way ahead on the course they must follow, and then refreshed themselves with vodka (despite the fact that it was six o'clock in the morning). The *Lenin* left them now, and *Komet* continued in the wake of the *Stalin*. In a short while the ice was reached, and *Komet* followed *Stalin* into it.

This was Eyssen's first experience of working with an icebreaker in Arctic waters. He found it fascinating:

'It was highly interesting and instructive to see the sureness and skill with which the icebreaker found the best way

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through. The colour of the sky and of the ice plays a part here. As forecast, the ice concentration was between one and eight tenths. At first we got through well. But then it turned suddenly foggy, and from that moment on it was a difficult and tiring passage. The position of the icebreaker could generally only be made out from its foghorn – even a searchlight could not be seen. The point is that it is essential to follow close behind the icebreaker, because the pack ice very quickly drifts back into her wake. But it was a great advantage to us to be able to follow the trail of bilge-oil which the icebreaker was continually pumping out.'

Komet only got stuck once, and then *Stalin* quickly cut her free. The next morning the ice was thinning out, and shortly afterwards *Stalin* went about, leaving *Komet* to continue on her own. They had traversed 200 miles of ice.

Good time was made to the next strait, Proliv Sannikova. Another Soviet icebreaker, *Malygin*, was stationed here with orders to assist if necessary; but there seemed to be no ice about, and since *Malygin* would not be able to make more than ten knots, Eyssen decided to go on alone. He entered the East Siberian Sea in the evening of 28 August. This eastern section of the route is the most difficult navigationally, because of shallowness. The continental shelf extends hundreds of miles off shore, with the result that large areas of sea are not more than twenty fathoms deep. A ship drawing more than twenty feet may have difficulty in getting even within sight of the coast. And the charting of the region, in 1940 at least, was very poor. *Komet* got into no difficulties, however, and in spite of a stretch of sixty miles of light ice, was able to reach her next rendezvous, a small group of islands off the mouth of the Kolyma river, on the 30th. Here she met the fourth Soviet icebreaker which had been assigned to help her, *Kaganovich*. This ship was one of the *Stalin* class, and her captain, A. P. Melekhov, was the director of operations for the eastern sector.

This time there was no likelihood of being able to dispense with the assistance. Heavy ice, which had drifted down from

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the central polar basin, was pressing shorewards along the stretch of coast ahead. This is a common event for this particular region, so that although it lies nearly 500 miles further south than Proliv Vil'kitskogo, it has a record of being no less difficult to negotiate. There is often – and was now – open water close inshore, because the ice draws too much water to drift in there; but unfortunately most ships draw too much as well, so no advantage can be got from it. *Komet* followed *Kaganovich* into nine-tenths ice, and the difficulties were shortly increased by darkness, a gale with snow-flurries, and strong drift. Many times *Komet* found herself unable to move and had to be cut free. On one occasion even repeated runs by *Kaganovich* failed to break her out. Only sixty-one miles were covered that day. But the following night conditions eased a little, and both ships made better progress. *Komet's* rudder was found to be useless at one point, but when the pressure relaxed it was discovered to be no more than bent, and was still serviceable. By the morning of 1 September it seemed that the worst was over. But Eyssen got an unpleasant surprise of a different sort.

A boat was lowered from *Kaganovich* in the comparatively ice-free water, and Melekhov came across to see Eyssen. He had just received instructions from Moscow, he said, to lead *Komet* back again to the west. American ships had been seen in Bering Strait, and it was therefore not safe for *Komet* to continue in that direction. Eyssen, of course, was not a little taken aback. But having got this far, he was not going to give in easily. He emphatically refused to turn back, and said he would continue alone if necessary. The Soviet ice reports were being received aboard *Komet*, and he had a shrewd idea there might not be much more ice between him and Bering Strait. He also knew now how much he could expect of his ship in ice. *Kaganovich* was required at Mys Shelagskiy, half a day's run further east along the coast, for other duties. Eyssen asked the Russians to take him along, and to wait for more information when they got there. This was agreed. However, no more information came. Eyssen received no instructions from Berlin (the Russians had led him to believe some were on their way to

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him). Furthermore, at Mys Shelagskiy the latest ice reports came in, and they reinforced his earlier impression of conditions ahead. After carefully inspecting the hull of his ship, and finding no damage caused by the ice, he made up his mind. He handed Melekhov a letter acknowledging receipt of the information passed to him and thanking the Russians for satisfactorily discharging their part of the contract. He further declared that the presence of ships in Bering Strait was no danger to him, because 'I am in possession of all the means needed to leave Soviet territorial waters unnoticed'. With that, he expressed his intention of disembarking the two pilots and proceeding the following morning.

This incident is difficult to explain. The story of patrols in Bering Strait was probably not true. The Russians would not have given in so easily if it had been, for it would have been most embarrassing for them if news of the voyage leaked out. Was there a cooling off in Soviet-German relations? There was, in fact, about this time, but it was due to the signing of the German-Italian Agreement, which was concluded on 30 August, and it is most unlikely that the effect would have been felt at such a remote spot within two days. Neither could the Russians have been trying to delay the completion of the voyage until payment had been made, for the contract was not presented by them for signature until midday on 3 September, by which time Eyssen had sailed on alone. The German naval attaché in Moscow pondered all this, and the only explanation he could think of was that the Russians suddenly felt badly about the whole affair *vis-à-vis* Great Britain – in fact, about breaking their neutrality. At the party aboard *Stalin* on 26 August the two Russian pilots in *Komet* met friends and no doubt told them that *Komet* was not a merchant ship but an armed raider. This news may have got as far as Moscow, where someone who knew nothing about the arrangement may have tried to stop the voyage. This would be particularly likely if, as may well have been the case, the arrangement was concluded between the naval attaché and the Soviet Navy, by-passing the Soviet Foreign Office. We know that the German Ambassador's

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advice to von Baumbach when negotiations started was to try to do just that.

At all events, on the morning of 3 September *Komet* headed eastwards by herself. Keeping close to the coast, she met a patch of ice which took over an hour to negotiate; but open water was reached again, and full speed resumed. This final stretch along the north coast of Chukotka does not have the reputation of being easy from the ice point of view. But the north wind, that would have brought the ice down towards the shore, was lacking. Instead, a strong wind from the west speeded *Komet's* progress, and in the small hours of the morning of 5 September she entered Bering Strait, having seen no more ice at all.

So ended the Arctic portion of the cruise. It was only the beginning, of course, of the whole voyage. This lasted for another fifteen months, during which *Komet* accounted for ten Allied ships totalling 64,000 gross registered tons, had many adventures in the South Pacific, including a period south of the Antarctic Circle, and finally returned to Hamburg undamaged and without a man lost. But for all the military success of the trip, in the long run it is the traverse of the Northern Sea Route which is the most significant thing about it. The time taken was a record, as we have seen. It showed what could be done when all the ancillary services were put at the disposal of one priority ship. Admittedly, *Komet* had good luck: all five straits she passed through were free of ice, and there was much less fog than there might have been. But probably even the Russians were surprised at the result. This was the first strategic use which the route had been put to. Since strategy has undoubtedly been one of the motives of the Russians in exploiting the Northern Sea Route, it is ironical that the first to benefit should have been her future bitter enemy. But it was quite clear now what use the Russians themselves could make of it. They never had to in the Second World War, because they were never (apart from six days in 1945) fighting in the Pacific. The news of *Komet's* voyage made the other naval powers of the world realize that the Soviet Union could transfer units between At-

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lantic and Pacific, virtually without leaving territorial waters and probably unseen (radar across the forty-five-mile-wide Bering Strait would be the only way to see them). Although she could only do this in the comparatively short period when the route was open, it could nevertheless be of great importance.

CHAPTER FIVE

The Northern Sea Route

So much for particular voyages and expeditions. What of the framework within which they were all planned and executed? The answer to this question is bound up with the attempt to run a freight-carrying sea route along the north coast of Siberia – one of the most interesting, and perhaps one of the most spectacular developments in the Soviet Arctic since the Revolution. These waters are icebound and impassable for shipping for at least seven months in the year – in some parts for eight, nine, or ten. In the remainder there is still plenty of ice about, and this in turn causes fogs, which tend to be most frequent in the months when there is least ice. So it is not a very easy place for seafaring.

This is not a purely Soviet idea, of course. It has a history, and quite a long one, for this is the old North-east Passage. But since I want to make this book as nearly topical as the existence of an iron curtain will permit, I will cover the history in a couple of sentences. Before the Revolution ships had sailed fairly regularly into the waters at either end of the 3,000-mile coastline: in the west from the North Atlantic into the Kara Sea, where the lower reaches of the big Siberian rivers Ob' and Yenisey were the destinations; in the east from the Pacific through Bering Strait to the river Kolyma. But the whole length of the route had only once been navigated, by the Swedish explorer Adolf Erik Nordenskiöld in 1878–79. In Soviet times it was decided to put a large effort into making this route work. If all points along the north Siberian shore could be made regularly accessible to shipping, then an enormous area of hitherto unexploitable territory could be made useful. There was possibly a strategic side as well: by using the North-

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ern Sea Route (as this waterway came to be called), Soviet ships might pass between European and Far Eastern Russia without crossing foreign and potentially hostile waters, and indeed practically without losing sight of the Russian coast.

Making the route work involved organizing a large number of ancillary services. A fleet of icebreakers had to be built up and kept in service; the imperative need of having the best possible weather and ice reports meant establishing a network of meteorological stations (by the outbreak of war there were about seventy along the coast of the islands and mainland) and keeping a number of aircraft for ice reconnaissance flights; a hydrographic service was needed to chart these largely unknown waters and to provide lights and buoyage; finally, a large staff of scientists working mainly under the control of the Arctic Institute at Leningrad dealt with the many scientific problems. All this activity was co-ordinated by a Government Department set up specially for the purpose in 1932 – the Chief Administration of the Northern Sea Route (Glavsevmorput is the Russian portmanteau word for this).

The efforts of Glavsevmorput resulted in a quick expansion of traffic along the route in the middle 1930's. The year 1936 was particularly good, with over 100 ships sailing in various parts of the route during the season. Operations in 1937 were planned on an ambitious scale, but there was a major disaster. Difficult ice in the central part of the route and inadequate ice reconnaissance were factors in creating a situation in which twenty-six ships were forced to winter at sea, among them seven out of the eight serviceable icebreakers owned by Glavsevmorput. This had far-reaching effects. Coming in 1937, at the height of the purge of leading Communist figures, the disaster was at once ascribed to sabotage by enemies of the people, and the purge was rapidly extended to include Glavsevmorput. Several heads of department paid dearly for a situation for which they were very likely not to blame at all. When the excitement had died down and more sensible reforms had been carried out, one result was a curtailing of the very considerable powers of Glavsevmorput. It had been growing into what was

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almost a state within a state, for it had responsibility for a great range of industrial and commercial activities in an area more than a quarter the size of the whole country. It was now directed to concentrate its attention on the prime task – running the sea route. The empire-building was over, and Glavsevmorput functioned, and continues to function, simply as a sea-transport executive. In a sense, therefore, 1938 marks the beginning of another phase in the work of the department and therefore in the development of the Soviet Arctic.

The 1938 season had to start with extrication of the ships which had wintered at sea. There was only one icebreaker available for this, the *Yermak*, which was the oldest ship in the Arctic ice-breaking fleet. She was launched in Newcastle in 1898, but in spite of her age she did a tremendous job in releasing one group after another of the trapped ships. In the end all but two were able to steam to port; one of these was crushed by ice and sank during the winter, and the other was the *Sedov*, whose story has been told.

Much time and energy that would have been devoted to the passage of cargo-ships was thus spent in relief work. The result, of course, was a lower freight turnover than in 1936 (256,000 metric tons against 271,000). In this year, as in all previous years, well over half the total amount of freight lifted was carried by the traffic between ports on the lower Ob' and Yenisey and western Europe. This was the flourishing timber export trade centred at Igarka on the Yenisey. Timber is one of the most accessible products of Siberia, and there was a ready market for it abroad. The growth of Igarka from two or three fishermen's huts in 1927 to a lumber town of 20,000 in 1939 is mentioned with pride by Soviet writers. In 1938 forty-five ships called there to load timber; most of them were not Soviet and were bound for western European ports. Besides this traffic across the Kara Sea, convoys sailed to the Laptev Sea from both Atlantic and Pacific ends, to the east Siberian Sea from the Pacific, and a number of ships had to do the routine jobs of relieving polar stations and isolated settlements.

The pattern of activities in 1939 and 1940, the other pre-war

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seasons, was similar, but on a rather larger scale. The timber traffic remained the largest single item, and the other voyages were spread fairly evenly over the ports and river-mouths further east. There was some increase in the number of 'through voyages' from one end of the route to the other, calling at various ports en route. In 1939, for instance, a group of four dredgers and four tugs sailed from the Atlantic to the Pacific. They were helped at difficult places by icebreakers, but had no whole-time escort. The fact that this sort of voyage could be made successfully is an indication of how far the route had been made workable. Another remarkable through voyage was the *Komet's* in 1940. The year 1940 also saw the first voyage from one end to the other and back again in the same season; this was done by the icebreaker *Iosif Stalin*.

During this period the Soviet icebreaker fleet received important reinforcements. It had hitherto consisted almost exclusively of British-built ships launched before or during the First World War. They were still giving good service – some are doing so even now – but the lack of powerful modern vessels was being keenly felt. Glavsevmorput put in hand a building programme in 1935. In 1938, after many delays, the first ship of the four planned, the *Iosif Stalin*, reached the Arctic. She was the first icebreaker to be built in the Soviet Union, or perhaps one should say the first modern one built there. For the Russians claim that the idea of using ships to break ice originated with them, just as they claim to have invented aircraft, radio, television, penicillin, and goodness knows what else, and as in all these cases, they produce enough evidence to show that there may be a grain of truth in their story. However, the *Stalin* was, when she was built, the best-equipped icebreaker afloat. She was about the same size and power as the biggest of the old ships – 11,000 tons maximum displacement and 10,000 total normal horse-power – but had many improvements in design: greater strength was built into the hull, and three aircraft, with catapult launching gear, were carried. There was one poor feature – she burnt coal. Experience outside the Soviet Union had shown that Diesel-electric power was much superior

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in performance and better suited to the job. This was recognized by Soviet engineers, but presumably the deciding factor was the availability of coal in the Soviet Arctic and the absence of oil. The *Stalin* was followed by three sister ships. All four were in service by the end of the war, and they quite transformed the icebreaker fleet. During the war there were further additions, this time from the United States. Under lend-lease, three *Northwind* class ships were transferred to the Soviet Union. They had just been built, and were about as powerful as the *Stalin* class, but with Diesel-electric engines. They were returnable at the end of the war, and after innumerable requests they were in fact returned, one in 1949 and the other two in 1951. The fact that they came back at all seems to indicate that they had by then been replaced by other ships. It is known that Soviet designers had plans both for an improved version of the smaller type of British-built icebreaker and for ships of a much larger size – even up to 24,000 tons displacement and 52,000 h.p. There is no information on what has in fact been built, although it is quite certain that the giant ships of 52,000 h.p. are pipe-dreams up to the present. But there have been important additions from foreign sources. It is known that the Finns, in payment of reparations in 1944, had to hand over six icebreakers, including their biggest, the *Jääkarhu*. The Russians have also ordered and received three Diesel-electric icebreakers from the Finnish yards since the war, the *Kapitan* class, which are about as powerful as the *Stalin* but not so big (10,500 h.p. and 5,500 tons displacement); they have further ordered two of 22,000 h.p. from the same yard, for delivery in 1958–60. And the most spectacular fact of all is the Russian announcement that they are building at Leningrad an atomic-powered icebreaker of 16,000 tons and 44,000 h.p., to be ready for 1959.

Meanwhile there has been progress in building up a fleet of ice-strengthened freighters. This has always been a weak point in the whole organization of the route, and there has long been talk of developing a freighter capable of dealing unaided with ice of up to moderate difficulty. By the war, this had resulted in three ships at the most. The rest of the freighters used were not

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designed for the job, and were quite often inadequate. Then in 1953 and 1954 a Dutch yard delivered three ice-strengthened Diesel-electric ships of 12,600 tons displacement and a cargo capacity of 6,500 tons – the *Ob'* class. They have given excellent service. Their ice-worthiness is such that they rank only just below an icebreaker, while carrying vastly more freight (icebreakers have notoriously small capacity, since their hold space is nearly all needed for engines). They have traversed the Northern Sea Route, and carried Soviet expeditions to remote corners of the Arctic and also of the Antarctic. The success of the first three has resulted in the ordering of three more, so that by 1958 there will be six sizeable and effective freighters in the Glavsevmorput fleet. Not all have been used for this purpose, however; the *Ob'* herself has served mostly as an expedition ship, a function she has performed very well.

Icebreakers are astonishing ships to sail in. The crash and clatter of ice against the ship's sides sounds extraordinary to anyone used to going in normal ships to normal parts of the world. Part of the reason why icebreakers can withstand it is, naturally, because they have tougher hulls, which do not get dented so easily, and more powerful engines, which force them forward through the ice. But the main reason is the actual design of the ships.

Practically all the icebreakers just described have the same main feature in their design: they break the ice by crushing it. The bows of the icebreaker are shaped so that they slide up on to the ice as the ship moves forward, and then the weight of the whole fore part of the vessel comes down on the ice and crushes it.

Other methods have been used. The idea of building the ship with a sharp stem, so that the ice would be cut, as with a knife, was tried quite early in the history of icebreaking. It can work well with ice below a certain thickness. One of the older Soviet icebreakers uses it – the *Litke* – and so do the special icebreaking freighters built in the late 1930's. A much more widespread feature is the bow propeller. Icebreakers built for the American Great Lakes at the end of the last century were fitted with a

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propeller at the bow as well as at the stern; the object was to make it easier for the ship to manœuvre – by using both fore and aft propellers a ship can turn round in its own length, like a London taxi – and to help in the actual breaking of the ice by sucking the water out from below it. But the snag about this was that in the thicker ice of the Arctic, where a ship may run into a great mass standing fifteen feet above the surface and extending perhaps sixty feet below, the bow propeller kept getting smashed and became more of a hindrance than a help. It is still used for icebreakers in places like the Great Lakes and the Baltic – some recent ships even have two – but it has to be removed if the ships go to the Arctic.

The newer icebreakers have a special device for breaking the ice by heeling over from side to side as they lie in it. The sideways motion comes from the very rapid pumping of water ballast from tanks on one side of the ship to tanks on the other side. Any ships built since the war will be certain to have this.

But we are getting ahead of the story. We left the Northern Sea Route in its last pre-war navigation season. It was a season of considerable activity, and the total freight turnover is thought to have been nearly half a million tons. This is the last absolute figure we have (and it may be somewhat exaggerated). We do have one other interesting piece of information, however. During the war the Germans captured a copy of the Soviet State Plan for 1941, a document which was not for publication, but for limited circulation in Government departments. The Americans then captured it from the Germans and published it. It tells us that the total turnover planned for the Northern Sea Route in 1941 was 240,000 tons. This figure is considerably lower than the total for several years before the war, but it must be remembered that the plan was drawn up in the knowledge that the war was on and that the Kara Sea traffic would presumably be much reduced. If this is taken into account, it will be seen that the volume of traffic in the other sectors was to be not less than in previous years. It is doubtful if the plan was fulfilled, since the Russians who drew it up early in 1941 obviously did not make allowance for being in the war themselves by

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the summer; and the German attack must have dislocated things seriously.

This piece of information does make one thing quite clear: the route cannot possibly at that time have been a paying proposition, or anywhere near it. The overhead expenses were very great. It would have been possible to recover them only if the turnover was high. With a turnover of 240,000 tons the freight charges would have had to be quite prohibitive. But if the route did not pay then, this does not prove that the Soviet Government did not ever intend to make it pay. While we must allow that strategic motives may have played a part, it is also possible that there was a long-term intention to run the route on an economic basis. The figures for subsequent years would tell us something on this point, but we do not have them.

Almost all that we know about the working of the Northern Sea Route during and after the war comes from sources outside the Soviet Union. One thing we know for certain is that the route was used to bring lend-lease supplies to the Soviet Union from America. While most of these supplies came to Murmansk, or Vladivostok, or across Persia, a steady trickle of twenty or thirty ships each summer sailed up the American west coast, through Bering Strait and along the north Siberian shore. This route was used for four seasons, from 1942 to 1945, and the total tonnage of goods transported was not far short of half a million. The ships were all entirely Soviet-manned, because in this way they might expect, as neutrals, to avoid attack by the Japanese. The destinations of most of the ships were ports east of Mys Chelyuskina, though some went on to the Kara Sea and even to Arkhangel'sk and Murmansk. Many had been chartered for a number of seasons before the war by Glavsevmorput, and had therefore been in these waters before, but some were American-built Liberty ships, themselves lend-lease goods. These were bigger than any of the freighters used up to that time on the Northern Sea Route, and it is interesting that they were apparently successful and were not unduly troubled by the shoals which in places extend far from the coast. We know no details of these voyages; only that there seem to have

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been no disasters, since the Soviet Government sent a general acknowledgement that 'everything had arrived'. What we do know comes from the manifests of the ships, drawn up before they left the United States. And from these it seems clear that most of the goods brought in to the north Siberian ports were maintenance stores for Arctic undertakings. Food and fuel were the main commodities, followed by much smaller quantities of such items as airfield equipment, industrial plant, and trucks. As far as one can tell, this route was not used to bring in supplies destined for the front or for the large industrial centres. This tends to confirm the impression gained from pre-war operations: that they were concerned mainly with making the route usable and were not yet of special significance in the economic life of the country. But this is one side of the picture only: goods coming in from America. There is no reliable information about what Soviet ships may have brought out of the Arctic.

What about the shooting war? These distant waters were never a major theatre of naval operations, but a number of actions were fought here between Soviet convoys and German U-boats. Once again the picture is one-sided. Soviet accounts mention only the loss of a survey vessel, a tug, and two barges, and record the fact that Dikson, the wireless station and base at the mouth of the Yenisey, was bombarded. Much more than this went on, as will be seen. But the only account available clearly comes from a German naval source, so there may be some exaggeration in the other direction.

The German naval effort in the Arctic was directed mainly against Allied convoys to Murmansk and the White Sea, but shipping on the Northern Sea Route was also attacked. These operations were carried out chiefly by U-boats based in north Norway, aided by some air reconnaissance and, on one occasion, a surface ship. The first season for which attacks were planned was 1942. Reports of shipping at the western entrance of Matochkin Shar and off the coast of Novaya Zemlya brought a U-boat to the area. A merchant ship was torpedoed, a shore station bombarded, and some barges carrying troops

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were sunk. (No doubt these last two were those referred to in the Soviet account.) Mines were laid off the entrance to the straits. Meanwhile, in August 1942, an attack into the Kara Sea was made by the heavy cruiser *Admiral Scheer* and two U-boats. The Germans had had Japanese reports from Bering Strait that a particularly large lend-lease convoy was coming through. The cruiser and the U-boats entered the Kara Sea by rounding the northern tip of Novaya Zemlya; all the other entrances were either mined or continuously observed. Another U-boat had to remain north of Novaya Zemlya to patrol the ice-edge to the north; obviously they could not risk the only exit being blocked by ice. The *Admiral Scheer* spent twelve days in the Kara Sea, but she was not able to do much damage. Dikson was bombarded, as the Russians admit, but bad visibility and ice prevented the ships going much further east than this, and no Soviet shipping was seen. Clearly all traffic had been ordered to put inshore as soon as it was realized a German warship was about; the Russians knew she would not dare to remain long because of the ice risk.

The next year, 1943, there were more U-boats available. A bold step was planned: to set up advanced bases actually on Soviet territory. The area chosen was the northern part of Novaya Zemlya, and one shore base was established on the west coast and two on the east. It is not quite clear if a shore base was actually established. Generally, U-boats carried the necessary supplies. When at the base, they would lie on the bottom, half-submerged. The conning-tower would be camouflaged with mats, sometimes so effectively that even their own aircraft could not find them. They were never disturbed by the Russians, despite considerable radio traffic. Flying-boats operated from them for six weeks, but without very much success. Owing to bad weather and mechanical trouble only eight sorties were made and no ships were sighted. But the U-boats (there were between three and six operating) had some successes. The survey vessel, which the Russians admit losing, was sunk in the Kara Sea when it was uncomfortably close to the German advanced bases, three ships were sunk in the same sea

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east of Dikson, and an escort vessel was torpedoed off the west coast of Novaya Zemlya. The Russians were again holding up their shipping east of Mys Chelyuskina in the hope that the Germans would be forced by the threat of the ice to retire. At the end of September a convoy was permitted to come on from the Laptev Sea, and this the U-boats caught, after many weeks of lying in wait. An escort vessel and four or five merchant ships were sunk. The U-boats did not finally withdraw until early November.

Another cruiser operation, this time with the *Lützow*, had been planned for this summer, but it never took place; evidently the Germans would not risk such an important ship unless there was reliable information about a worth-while target.

In 1944 there were again about six U-boats operating in the Kara Sea. They sank several escort vessels and two merchant ships in a number of actions. The Germans knew that the Soviet ships were once again being held in the Laptev Sea, probably at Nordvik on the estuary of the Khatanga, and made a bold attempt to pass through the narrow and often ice-filled strait off Mys Chelyuskina – Proliv Vil'kitskogo – in order to reach them. But the ice in the strait defeated them. At the end of the season one U-boat landed a party which surprised the Soviet weather station at Mys Sterlegova, on the mainland east of Dikson. Bad weather forced the attackers to remain on shore for three days; but they were able to continue the radio traffic on the Soviet net without arousing any suspicion. This raid put the Germans in possession of some interesting information on how the Soviet weather stations were organized.

During the three seasons' operations U-boats claimed to have sunk eleven or twelve merchant ships totalling 42,000 gross registered tons, one destroyer, five escort vessels, a tug, and some barges, and to have bombarded a number of shore stations and laid a great many mines. This was done for the loss of two U-boats. The German reports suggest that the Russians had not expected to be attacked in the Kara Sea at all. The counter measures the Russians took became increasingly effec-

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tive year by year, but nevertheless the losses seem to have been quite considerable. The effect of the ice was interesting. No U-boat appears to have been badly damaged, though there were cases of bent periscopes and curiously inaccurate torpedoes. The latter were thought to have been damaged by earlier shocks in the ice, or by low temperatures, or possibly their acoustic direction-finding gear may have been affected by echoes from ice. In general, the ice probably helped rather than hindered the U-boats, because it concentrated the Soviet convoys into narrow waters.

The Soviet icebreaker fleet seems to have survived the war almost intact. The *Stalin* class ships had various adventures. One, the *Anastas Mikoyan*, got out of the Black Sea (where she had just been completed), across the Mediterranean, the Red Sea, and thence to the Arctic. The crossing of the Aegean under the noses of the Germans, who were occupying the Greek islands lying off the coast of Asia Minor, was the most exciting part. It is mentioned in *No Stars to Guide*, an attractive book by a British naval officer, Adrian Seligman, who was engineering the escape of another ship by the same route at the same time. The British officer taking the *Mikoyan* through found her crew extremely efficient and the navigation equipment first class. Later she and the *Stalin* both went to the United States for repairs. The old British-built *Sibiryakov* was probably sunk, and possibly the *Malygin* too; both names have been given to two of the ex-Finnish icebreakers. The old *Yermak* spent the war at Leningrad, from which she could not escape. But she survived. In 1949 – her fiftieth birthday – she was awarded the Order of Lenin, and in 1957 she was still reported as patrolling the Kara Sea. The *Litke*, another veteran built at Barrow in 1909, was active on the Northern Sea Route in 1954 and 1955. The Soviet icebreaker fleet is therefore still by far the largest in the world, even if we do not know its exact size.

That is all that is known of war-time activities. It is not a great deal, consisting largely of what the Americans knew about lend-lease convoys and what the Germans knew about naval operations in the Kara Sea. The Russians certainly did

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much more than either of these accounts tell about. There was probably a good deal of Soviet coastal shipping, for the polar stations, mining settlements and trading posts had to be kept supplied (lend-lease ships called only at the principal ports and anchorages, and from these supplies had to be distributed); possibly the timber from Igarka was still brought out to Arkhangel'sk, but this seems less likely because there were plenty of other, less remote, places, where timber could be obtained. A report in *Pravda* does mention that Igarka wood was brought out, as well as coal, fish, fur, and salt; but since no idea of the quantities are given, this report really means very little. There is a strong presumption that Soviet naval forces passed along the route in order that either the Pacific or Atlantic fleet might be reinforced without the enemy's knowledge. This is certainly true of 1945, when the Soviet Union was about to enter the war against Japan; Henry Wallace, then Vice-President of the United States, refers to the passage of a 10,000-ton cruiser in his book *Soviet Asia Mission*.

After the end of the war the information on what has been happening has been even more scant. There is only one branch of activity about which we do know something fairly solid: the Kara Sea timber traffic.

This information is available because many foreign vessels, including British, have been working on this route since the war. Apart from one British ship which went to Igarka in 1947, the traffic did not start again until 1949. In that year at least eight ships called there. The total crept up year by year, and in 1956 the Russians announced that seventy ships loaded there. So it may fairly be said that traffic on this part of the route has revived.

These foreign timber-ships have all used the same route to and from Igarka. They call first at Murmansk, where they pick up two Soviet pilots for the Kara Sea. When they call here the ships are also 'controlled', a process which includes putting a seal on all binoculars and cameras; the binoculars are unsealed when the port is cleared, but the cameras remain locked up until the ship leaves Murmansk on her homeward passage a

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month later. The ships pass through the Karskiye Vorota, steam north-east to Ostrov Belyy, round it on the north side, and make for Ostrov Diksona, which they leave to port as they enter the Yenisey. At its mouth two river pilots come aboard and they take the vessel the 400 miles upstream to Igarka. The return trip is just the same process in reverse. All the ships are on charter to the Soviet authorities, and as each passes the meridian of Murmansk she comes under the command of the Chief of Kara Sea staff. He has the job of keeping the ships clear of ice. His Government is paying part of the insurance premiums for them, but this does not prevent him from keeping the ships as far away from ice as he can. And in fact he has been very successful, for no ship seems to have had difficulty since the war. It is true three have gone aground, and one – the *Beckenham* in 1953 – struck a reef and became a total loss. These mishaps have no doubt affected the insurance premiums, but none has in fact been due to ice.

Whether the partial revival of the Kara Sea traffic reflects what is happening on the rest of the route it is difficult to say. There is no particular reason why it should, because use of this leg of the route depends much more on Soviet foreign trade policy than on policy towards Arctic development. What can Soviet sources tell us about this?

The main piece of published news about the Northern Sea Route to appear in the first eight years since the war was the story of a voyage which took place in August and September 1949. It was necessary to provide the river fleets of the Ob' and Yenisey with new powered craft and barges. These apparently had to be built on the Volga, and the only way of getting them to their destinations by water was to send them by way of the Arctic. Modifications necessary for sea-going had to be made: for instance, compasses were fitted – normally river craft have none.

After a careful check the convoy left Arkhangel'sk, each ship towing several barges. No icebreaker escort was to be provided, but a tanker came with them. They waited at the straits leading to the Kara Sea until the ice further on was reported favourable. When this report was received they all set out into the

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Kara Sea. Two days out the wind changed, and the unprotected ships found themselves in fog and surrounded by ice. They drifted for fifteen hours, and then successfully extricated themselves. After this there was a storm which forced them to shelter in the seldom-used Proliv Malygina, between Ostrov Belyy and the mainland. Ordinary ships cannot navigate this strait with any safety because of the shallow water, but river craft, which draw very little, could afford to take the risk. A few days later they reached their destinations – Salekhard on the lower Ob' and Igarka on the Yenisey. It was indeed something of a feat to get these craft round in safety, and Stalin sent a congratulatory telegram (which perhaps accounts for the publicity given to the whole thing). The leaders of the expedition got Stalin prizes – large sums in cash awarded annually to inventors in all spheres.

Apart from this narrative, there have been short news items. They mention, for instance, that certain icebreakers have been working in this or that area, or that ice reconnaissance patrols have been active. There have been reports in the foreign Press of the passage of naval vessels and troopships, but these are generally unsubstantiated. But since 1954 there has been a particularly copious – by previous standards – release of information, which included an announcement in 1954 that annual freight turnover had increased fourfold since 1940 – presumably to somewhere between 1 and 2 million tons. This was couched in somewhat vague terms, but it was the Minister responsible who wrote it. This figure is compatible with another equally authoritative statement made in 1957, that turnover had now reached nearly ten times the 1933 figure – giving an answer of about 1,300,000 tons. There were more references to continuing traffic, and another report of river vessels using the route to reach the Siberian rivers – this time some went to the Lena as well as the Ob' and Yenisey.

But the most important of all is the story of the high latitude air expedition of 1954 and the setting up of the drifting stations. An outline of the narrative has already been given, but two aspects of it are relevant here. One is that the main

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stated object of the expedition was to find out about the water and ice circulation in order to improve ice forecasting for the Northern Sea Route. This, if true (and there is certainly some truth in it) is an interesting measure of the scale of the ancillary activities: an organization which can divert thirty-five aircraft to help secure useful information about behaviour of the ice must have considerable importance. The other is that the reports on the expedition mention a number of airmen and scientists – I. P. Mazuruk, I. I. Cherevichnyy, M. A. Titlov, Ya. Ya. Gakkel', A. F. Treshnikov, P. A. Gordiyenko, V. G. Kanaki, A. D. Malkin, and many others who were in polar work a long time ago, in several cases more than twenty years. It is fair to assume that they have been doing it continuously, or they would not still be together. It would seem therefore that there has been no reduction in Glavsevmorput's activities despite the silence surrounding them. In fact, the 25th anniversary of the creation of Glavsevmorput, falling in December 1957, received considerable notice in the Press, and the impression given – though with virtually no hard facts quoted – is that the whole organization is growing and prospering.

There is also information about changes in personnel and administration. The Head of Glavsevmorput was at first the capable and intellectually brilliant Academician Otto Yul'yevich Shmidt, who did the pioneer work, but left the job in 1939, having apparently survived the purge which followed the disastrous season of 1937. After him came Ivan Dmitriyevich Papanin, convivial, energetic, a very good Party man, and hero of the North Pole Drifting Expedition. He was succeeded in 1946 by A. A. Afanas'yev, a shipping and port expert. In 1950 came Major-General Kuznetsov of the Naval Air Force.

In 1954, or perhaps 1953, a man with a keen scientific interest was appointed – Vasilii Fedotovitch Burkhanov, who first went to the Arctic in 1936 as a ship's engineer and has been with Glavsevmorput ever since. He was a friendly man, who welcomed foreign interest in his department's work; but in 1957 he was replaced by Afanas'yev, although staying on as his deputy.

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Again, immediately after Stalin's death a number of Ministries were reorganized. As a part of this process the Chief Administration of the Northern Sea Route (a Chief Administration ranks next below a Ministry) was merged with the Ministry of the Merchant Fleet and the Ministry of the River Fleet to form a single Ministry of the Merchant and River Fleet. The new minister was Z. A. Shashkov, whose interests lay in inland waterways. This change could be interpreted as implying a lessening of the importance of Glavsevmorput. But less than eighteen months later, in August 1954, there was another reorganization and the two ministries again became independent. Shashkov took charge of the river fleet, and Glavsevmorput remained attached to the Ministry of the Merchant Fleet. So it looks as if the changes were unconnected with any variations in the importance of Glavsevmorput, but were made for quite different reasons.

This sort of information allows one to say one thing with certainty: that activities do continue on at least as big a scale as before. There is no question of the whole thing being dropped. But there is almost no detail to fill in. It may be that Siberian rivers are being used more now and that certain economic undertakings near their lower reaches may be supported in this way and not by sea. This could, if true, reduce the usefulness of the sea route, but it could never take its place. If activities continue techniques will have been improved. So greater efficiency may be assumed as a result of better forecasts of ice conditions, also better traffic planning, and probably some lengthening of the shipping season. The stage is certainly passed when it was an 'expedition' to send ships to northern Siberia; although the Northern Sea Route may not yet be quite a 'normally working waterway' (as three Five Year Plans, of just before and after the war, proclaimed that it was to become), it can be no more than a matter of routine for Soviet ships to go wherever they want along its length. That is undeniably a great achievement, and one which contrasts sharply with corresponding development in the western hemisphere. But it is also in a way a precarious one; for a very small cli-

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matic change could undo all the effort that has gone into it by making the ice conditions impossibly bad (and they are known to have been particularly favourable during the years of the Soviet experiment).

What of the motive? The secrecy which the Soviet Government has enforced since 1947 makes one suspicious. But if one suspects large-scale military activity, one may be exaggerating the importance of the strategic side; much purely economic information is also kept secret. There is a strategic side, certainly; but it is also true that further development could make the Northern Sea Route useful economically to the Soviet Union.

CHAPTER SIX

Soviet Rule and the Peoples of the Arctic

The Soviet Arctic, like most other Arctic territory, is very sparsely inhabited. But whereas Arctic America and Greenland have only one indigenous racial group – the Eskimo – the north of Eurasia counts a number of distinct peoples. Some of them are numerically very small, consisting of only a few hundred, while others number a quarter of a million or more. The map on pp. 110–111 shows the names and numbers of the tribes, and where they live. They are generally divided into three broad groups, on the basis of their languages (not enough is known about all of them yet to group them by their racial origins).

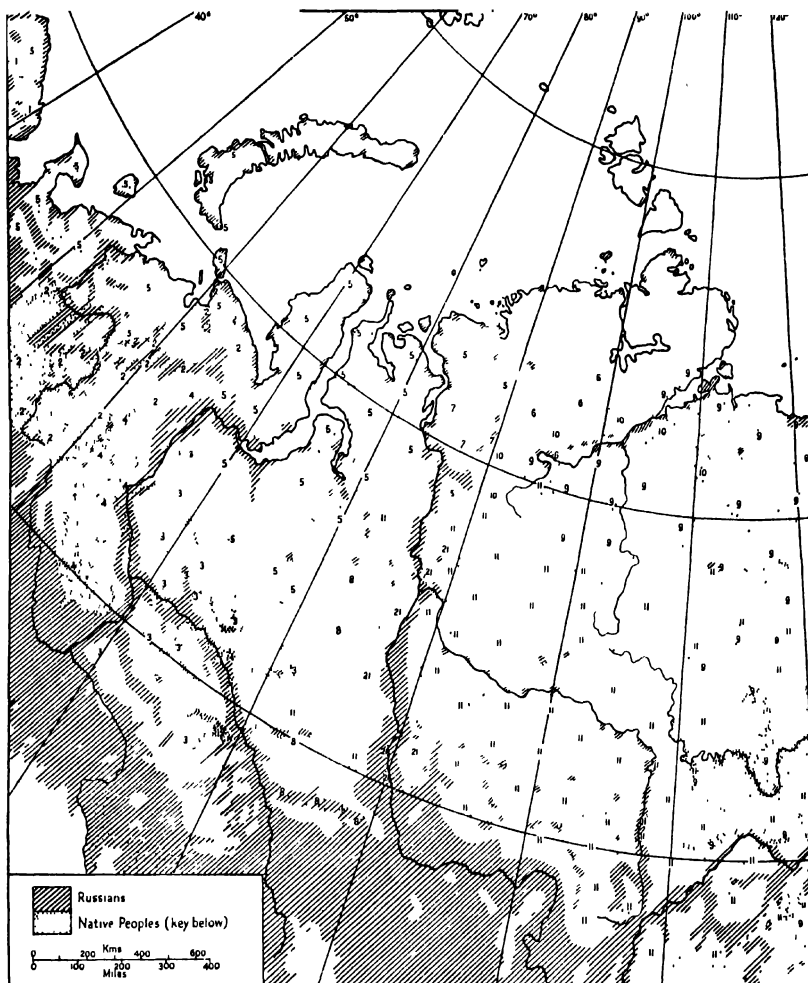
Among the group occupying the western part of the Soviet Arctic, called the Uralian, are some peoples whose names at least are familiar. Here, for example, are the Lapps (called Saami by the Russians because that is what they call themselves). They are the same family as the Lapps in northern Scandinavia, but there are not so many of them. 'For the practice of witchcraft and sorcerie they pass all nations in the worlde,' said Giles Fletcher, Queen Elizabeth's Ambassador to Moscow, in 1588; but he went on to reassure travellers that the current belief that they could enchant ships that sail along their coast was in fact an exaggeration. The Lappish language is an offshoot of Finnish.

The most numerous people in the Uralian group, and in fact in the whole Soviet north, are the Komi, over 400,000 strong. Then, to the east of them, live two more: the Khanty and Mansi on the banks of the river Ob'. This was the part of Siberia first

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reached by the Russians, among whom there was a popular belief that the inhabitants of these remote and cold expanses died annually on the 27th of November and revived, 'like frogs', on the 23rd of April. A final sub-group of the Uralians is the Samoyeds. They live on the shores of the Arctic Ocean from the White Sea to the Khatanga, north of the Komi, Khanty, and Mansi. Small bands of Samoyeds have lived on the Arctic islands of Novaya Zemlya, Kolguyev, and Vaygach. Their area is thus immense, but their numbers are comparatively small – about 21,000. It is as if the population of Aylesbury, or Dieppe, were the only inhabitants of France and Italy. It was the Samoyeds whom the early English and Dutch explorers met and heard tell of in these regions in the sixteenth century. Steven Burrough reports seeing them in 1556. One of his companions, Richard Johnson, witnessed the 'devilish rites' practised by the 'priest', and Hakluyt has the description in his great book of early voyages and travels. This is in fact the first account there is of a *shaman* (witch doctor) ceremony among these peoples. The *shaman* fell into a trance, to an accompaniment of weird singing, and then, jumping up, seized a sword, 'and put it into his bellie halfway and sometime lesse, but no wound was to be seen (they continuing in their sweet song still). Then he put the sworde into the fire till it was warme, and so thrust it into the slitte of his shirt, and thrust it through his bodie, as I thought, in at his navill and out at his fundament; the poynt being out of his shirt behind, I layde my finger upon it, then hee pulled out the sworde and sate downe.' They were exciting performances, and the last *shaman* is certainly not very long dead, if dead he is. Use of the name 'Samoyed' has been frowned upon by the Soviet authorities on the grounds that it was insulting to the natives – it suggests 'cannibal' in Russian. So within the group of tribes other names were substituted, generally the peoples' own names for themselves. Nentsy became the accepted name for the largest tribe, but there was no new word to cover the group, and Samoyed remains.

Moving eastwards, the second large group is the Altaic.



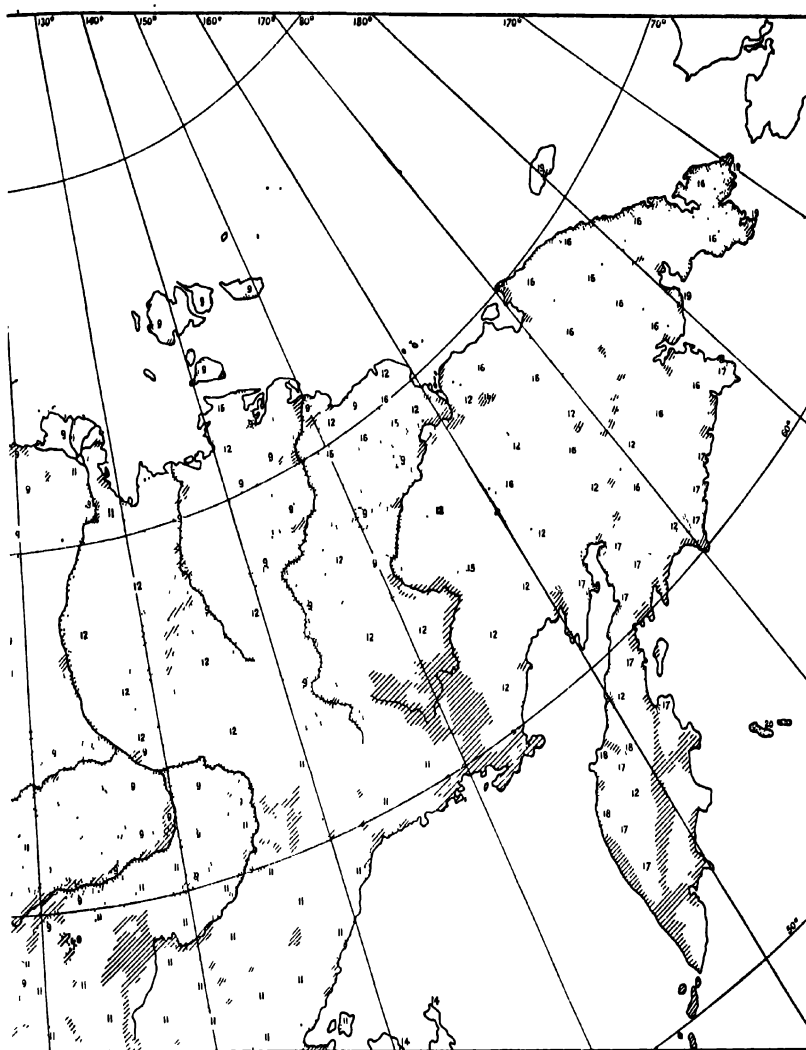
Map 5. The native peoples of the Soviet north. The key to the numbers is given brackets (often the old name is retained in Soviet usage). The population Komi, for whom the 1939 census figure is available. The number of Russians

URALIAN GROUP

1. Saami (Lapps) 1800; 2. Komi (Zyryans) 409,000; 3. Khanty (Ost-yaks) 18,000; 4. Mansi (Voguls) 6,000; 5. Nentsy (Samoyeds) 17,000; 6. Nganasany (Tavgiyskiye Samoyeds) 900; 7. Entsy (Yenisey Samoyeds) 400; 8. Sel'kupy (Ostyak Samoyeds) 6,000.

ALTAIC GROUP

9. Yakuty 236,000; 10. Dolgany 1,450; 11. Evenki (Tungus) 39,000; 12. Eveny (Lamuts) 7,000.



below. The Soviet name for each people is given first, with the old name in figures which follow are derived from the 1926 census, except in the case of the in the whole area is not known, but it far exceeds the number of natives.

PALAEOASIATIC GROUP

13. Negidal'tsy 450; 14. Nivkhi (Gilyaks) 4,000; 15. Oduly (Yukagirs) 450; 16. Luorovetlany (Chukchi) 12,500; 17. Nymylany (Koryaks) 7,500; 18. Itel'meny (Kamchadals) 800; 19. Eskimo 1,300; 20. Unangany (Aleuts) 350; 21. Kety (Yenisey Ostyaks) 1,250.

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The Yakuts, numbering nearly a quarter of a million, are without doubt the most advanced of the peoples of the Asiatic north. It is said that the skill of the Yakut hunters in shooting their quarry in the eye (in order not to damage the fur) made them the best marksmen in the Red Army. They speak a Turkic language, which is one reason for supposing that they originally came from more southerly regions. They now live in the Lena basin, and their territory is about the size of Mexico or the Republic of India.

The other representatives of the Altaic group are the Tungus tribes. Like the Samoyeds, these have new names; and the old name, which could not give offence to the most delicate-minded Soviet administrator, survives to denote the group.

The final group is the so-called Palaeoasiatic, which embraces the peoples of the Pacific seaboard. Linguistically, the relation between members of this group is far from clear, but the languages have sufficient in common to justify their being grouped together. The Chukchi (who should be called Luorovetlany now, but the old name persists even in Soviet usage) are the most warlike people of northern Siberia, and resisted the Russian advance for a long time. To the south of them live the Koryaki, and south of the Koryaki, at the southern end of Kamchatka, are the Itel'meny or Kamchadals. These three peoples have much in common; their languages are related, they hunt in the same sorts of way, and in physique and looks they all resemble the American Indian type. But the other members of the Palaeoasiatic group cannot be classed together like this.

Outside the three groups there are two other tribes that should be mentioned, though they are small. The Asiatic Eskimo survive in the extreme north-east of Siberia, on the shores of Bering Strait. It is known from archaeological evidence that all Eskimos in Arctic America and Greenland came originally from this region; but now the Eskimos left in Asia have been largely assimilated by the Chukchi, their neighbours. And finally, more as an oddity than anything else, the Aleuts should be included. About 350 of them live on the Soviet

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islands in the Pacific off Kamchatka, the Ostrova Komandorskiye or Commander Islands. These islands were uninhabited when the explorer Bering discovered them in 1741. There were no signs of habitation visible then, and the point seems to be proved by the fact that the foxes on the islands were so unafraid of men that they bit the sailors' toes when they were asleep. The islands were populated in the nineteenth century by Aleuts brought from the neighbouring Aleutian Islands, which at that time belonged to Russia. Men and women of many other races came later, but the Aleuts (or Unangany, as they call themselves) remained the nucleus, and they still predominate.

The natives of the Soviet Arctic, then, are a mixed collection of many nationalities. But they are unified in their common need to come to terms with their severe surroundings, and their cultures therefore have many similarities. They are mostly either reindeer herders, or fishermen and seal-hunters, and as such traditionally nomadic. Only the Komi and the Yakuts, at least until recently, know anything of farming. The numbers in each tribe, given on the map, are only approximate. Most are taken from the 1926 census (the figures of the 1939 census were never published in the case of the northern peoples), and it has been admitted that many mistakes were made by the census organizers. After all, the official taking the census could not be expected to appreciate the finer distinctions of ethnography in deciding just which tribe a group of natives belonged to; nor could he count nomads by any other method than enlightened guesswork. All that the numbers can be taken to show is the relative sizes of the tribes, and the small total native population of the whole area – some 800,000 inhabiting an area of not less than 8,000,000 square kilometres. This is as if the population of Liverpool, or Amsterdam, were spread over the whole of Europe. It is interesting to note that the most recent Soviet book on the subject, the bulky and authoritative *Narody Sibiri* [*Peoples of Siberia*], published in 1956, has to make do with figures from the 1926 census.

The names of the tribes are confusing also. The Soviet

authorities provided new names in almost all cases; this was often in order to do justice to the natives, as we have seen. But it is the old name which is better known abroad, because much of the ethnographic work was done before the Revolution – and some of the old names have remained in use even in the Soviet Union. For sometimes the new names were artificial and seemed to the natives absurd; and sometimes the ‘insult’ to the natives was more imaginary than real. To take the case of the Samoyeds; in the sixteenth century at least they were not very worried; as Giles Fletcher makes clear: ‘The Samoite hath his name (as the Russe saith) of eating himselfe: as if in times past, they lived as ye Cannibals, eating one another. . . . But as the Samoites themselves will say, they were called Samoie, that is, of themselves, as though they were Indigenae . . .’ – for the word does mean ‘self’ in Russian. But the result of all the re-naming is that one now has to mention both names.

In order to see what the effect of Soviet rule has been on these peoples, we must look a little into the past and see how they were treated by the Tsarist Government. There was a background of strong animosity between natives and Russians. Historically this no doubt dates from the Russian conquest of the native territory, beginning in about the tenth century with the advance of men from Novgorod into the region of the White Sea and the Pechora river, and starting again with the advance into Siberia in the late sixteenth century. The natives were overcome by the Russians in often very cruel fighting and were compelled to pay fur tribute to their conquerors. The outcome of the struggle in Siberia was never in doubt, for the Russians had firearms while their opponents were using bows and arrows. However, there were too few Russians in this vast expanse of territory to impose a heavy yoke on the widely scattered natives, and for long the tribesmen, though forced to pay the fur tax, were not seriously affected by the invasion. But as the Russian population of Siberia grew, the natives’ position got worse. This was to be expected, for the types of Russian who went to Siberia were scarcely the most enlightened elements; Cossacks after what they could get, landless peasants

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seeking better fortune, and then, in the nineteenth century, a million criminals and political deportees (though these last, of course, were sometimes a good influence). In the turbulent society that arose in Siberia it was quite natural that the native, unsophisticated, bewildered, and emerging from the Stone Age, should come off worst. So the natives were apt to be either brushed aside, if they could be of no use, or tricked into any sort of deal advantageous to the Russian, if this was a way of getting fur. Alcohol of course was generally included in the bargain, with results to the natives that have been observable among primitive peoples in all parts of the world. The orthodox priests, who were also quickly on the scene in Siberia, aroused great antagonism among the natives for their forcible (and, it seems, generally quite ineffective) conversions to Christianity. The missionaries were often altogether the wrong sort of people. There are plenty of reports of their being recalled and charged with drunkenness, or cheating or maltreating the natives. It became the accepted thing for bribes to be offered as an incentive to conversion. An impressive example of the animosity this aroused is found in an Ostyak Samoyed legend quoted by Kai Donner: the national hero of the tribe is found vowing vengeance on his people's two enemies, one being the devil and the other Christ, father of the Russians. It seems certain that no effective attempts were made by any Russian organization, governmental or otherwise, to better the lot of the natives. Equally, there was no deliberate interference with them, and any feeling of racial prejudice was entirely absent from the Russian attitude. If their numbers diminished during the period, as they certainly did, the Tsarist Government could be accused of gross neglect and failure to stop abuses, but not of a deliberately repressive policy.

In direct contrast, the Soviet Government has concerned itself on many occasions and in great detail with the peoples of the north. It has acted mainly in the field of administration, education, and economic reorganization. But before thinking about each of these, there is one point which should not be forgotten. One of the basic principles of Soviet rule was the

guarantee to every national minority within the Soviet Union of freedom to develop in its own way. The 'Declaration of Rights of the Peoples of Russia', issued before the Revolution of 1917 was a fortnight old, proclaimed the equality of all peoples, the abolition of national and religious privileges and restrictions, and the free development of national minorities. Further, the man entrusted with the job of seeing that this was put into effect was Stalin himself, who was Lenin's Commissar of Nationalities in the early years of the regime. The ideological side is of considerable importance, because the progression from a patriarchal or feudal social order towards socialism is here made to bypass the intermediate stage of capitalism – a development about which Marx and Engels had some doubts. There has been argument in the Soviet Union on this topic quite recently; the part played by the Russian proletariat in assisting this progression was not being emphasized enough, it was thought. At all events, it is quite clear that Soviet governmental action towards the northern peoples has not only been deliberate, but was carefully thought out ideologically and approved by the highest authority.

Soviet power made itself felt in the northern regions several years later than was the case in other parts of Russia. The Bolsheviks crushed the main resistance in Siberia in 1920, when Admiral Kolchak was defeated and executed at Irkutsk. However, small anti-Soviet groups continued to resist in the north for some time after this, and one Cossack colonel in particular held out in the Yakutsk region. But by about 1924 the last open resistance disappeared and the Soviet Government was free to put into practice its theories about the sovietization of the north. One of its first acts was to establish in 1924 the Committee for the Assistance of the Peoples of the North, which had the task of helping the natives carry out 'planned development in the spheres of economics, administration, law, culture, and public health'; of seeing, in fact, that the terms of the 'Declaration of Rights' were put into effect. This Committee, which became known as the Committee of the North, was directly subordinate to the All-Russian Central Executive Committee (or

parliament) and was very influential. It introduced Soviet ideas of government and cultural development to the natives in preparation for their taking a more direct share in their own administration.

The natives were formally given this share mainly in 1929–31, when the administrative division of northern Siberia was re-organized. In this region, the whole of which forms part of the Russian Soviet Federative Socialist Republic (abbreviated to R.S.F.S.R.), the administrative breakdown is of a dual nature. One series of sub-units is determined chiefly by considerations of economics and of administrative efficiency; and parallel to this is another series determined on the basis of nationality. This second series descends from Constituent, or Union, Republic (of which the R.S.F.S.R. is one), through Autonomous Republic (A.S.S.R.), Autonomous *Oblast'*, National *Okrug*, National *Rayon* to National Local Soviet (which may even be nomadic, if the tribe are nomads). The larger national groups are found higher up the scale; indeed, it is the intention of the system to permit each group to climb the ladder as it acquires political maturity. The Yakuts, as one of the largest national groups in the north, had acquired the status of Autonomous Republic in 1922 (their Republic is over five times the size of France); and the Komi were formed into an Autonomous *Oblast'* in 1921 and promoted to Autonomous Republic in 1936. The change of which we are speaking concerns the National *Okrugs*, *Rayons*, and Local Soviets. These were the levels considered appropriate for the smaller groups, and almost all the tribes were formed into one of these. The divisions were territorial, so that not all the members of a tribe were necessarily included, if the tribe was scattered over a wide area; and conversely, there might be a considerable proportion of inhabitants of the area who did not belong to the tribe giving it its name. There was a tendency for members of the tribe living outside to move into the 'national home' once it had been established. With the passage of time some national groups have moved up the ladder, advancing from National *Rayon* to National *Okrug*. The position in 1947 was that there were seven

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National *Okrugs*, of which three were for the Nentsy and other Samoyedic tribes, one for the Khanty and Mansi, and one each for the Evenki, Chukchi, and Koryaki; three National Rayons, for the Eveny, Nanai, and Nivkhi; and two National Soviets, for the Kety and Sel'kupy. There have probably been few changes since then. It is too early yet to see the effect of Khrushchev's regional economic councils set up in 1957. The Yakut and Komi autonomous republics each constitute one, but the new set-up may not much affect the nationalities problem.

The effect of this legislation (at least on paper) has been to ensure that a national minority can elect its own representatives to organs of local government. All but the smallest can also make their voice heard in Moscow, for every National *Okrug* sends one deputy to the Soviet of Nationalities (which, together with the Soviet of the Union, makes up the supreme legislative body), while the higher national areas send proportionately more deputies. The financial affairs of the National *Okrugs* and *Rayons* are kept separate from the parent administrative area, in order to make possible the different approach called for. In encouraging the natives to form their own Soviets, the authorities tried to cut across the existing social order – generally based on the clan – wherever possible. Getting rid of the natives' old loyalties to chiefs and *shamans* was one of the basic tasks of sovietization. This was not at all easy, and many attempts to organize Soviets on the new lines failed. The Chairman of the Soviet, for instance, would be at once accepted by the natives as the new chief, and their general outlook remained unchanged. In the end it was apparently the practical help they received which persuaded them that there might be some advantage in changing their ways: food supplies appeared in bad years, better hunting equipment was available, a fairer return than before was to be got for pelts. In this way, it seems, the natives came to welcome the introduction of Soviet rule.

This leads us to consideration of what was, from the Soviet point of view, probably the most important aspect of government: education. The word is used in the widest sense, to in-

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clude political instruction as well as learning to read and write; for the object of the more elementary forms of education was always political.

The task of educating the natives to participation in and appreciation of a socialist society had to begin right at the bottom. Not only was illiteracy almost universal, but in a number of cases the native languages had not even got a written form at all. Alphabets had to be invented, textbooks brought out, and teachers trained. Schools were started in 1925. By 1930 there were 131, not including the Yakut and Komi schools, but they were attended by only 20 per cent of children of school age. There was great difficulty in persuading parents to allow their children to go to school, particularly when they were nomads, and going to school meant leaving the family and boarding. In the course of time however, when the practical advantages of schooling became apparent, this difficulty was overcome. By 1934 the proportion of school-age children attending school was up to 60 per cent, and literacy among the native population as a whole was estimated at 30 per cent. (Literacy is taken in the Soviet Union to mean the very lowest level – familiarity with the alphabet.) Teaching was in the vernacular for at least the first year or two of school. After that, Russian was taught, and it was used as the teaching language if the native vocabulary was inadequate to deal with the subject taught.

The driving force in this sphere was the Institute of the Peoples of the North, set up in 1926 with the main purpose of training natives to be teachers and administrators among their own people. Between 1931 and 1937 the Institute turned out 206 native graduates, who returned to their territories. There was a research association attached to the Institute, and it was here that much of the basic linguistic study was done. The Institute disappeared in 1941, and the work of training natives and studying their languages is now done by the northern faculty of the Zhdanov University at Leningrad and teachers' training colleges at Leningrad and Khabarovsk in the Soviet Far East. While one can say nothing of the general standard

achieved at these places, it is true that some high-quality individuals have been trained there. One may mention for instance a talented young Chukcha named Rytkeu who wrote among other things a clever short story which appeared in a Soviet weekly magazine. In this story he tells about a journey home on the Trans-Siberian railway to his native land. Here he and his friend, another Chukcha, share a sleeper with a Belgian professor and his wife, who are visiting the U.S.S.R. The Belgians are delighted to meet this representative of a primitive people, who then proceeds to demonstrate just how far he is removed from the primitive.

The political education, which followed naturally from ordinary elementary education in the case of children, had to be handled rather differently for the benefit of the illiterate adults. A series of centres were established from which Soviet influence in as many spheres of activity as possible might radiate into the surrounding territory. These were called cultural bases, and generally included the local administrative organ, school, hospital, club, cinema, radio receiving centre, veterinary station, trading-post, and workshops of various kinds. They were set up in extremely remote and often quite uninhabited places – advisedly so, because it was hoped that the cultural bases would become centres at which nomads might settle. But it was not intended to wait for the natives to come to the bases; for in addition there were mobile centres. These, in the form of the so-called ‘Red Tents’ and ‘Red Boats’, went out after the nomads and provided services of the same sort as the cultural bases, but on a smaller scale. The Committee of the North was responsible for organizing these centres, and there is no doubt that their influence has been considerable. Some have indeed become regional centres in just the way it was hoped: Khatanga, for instance, was an uninhabited place before the cultural base was set up there. The practical nature of the help provided by the cultural bases and ‘Red Tents’ was a sound idea and proved effective in popularizing Soviet rule. The medical service is a good instance, for medical aid was almost totally unknown to the natives before these centres were instituted;

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at the same time the provision of a medical service helped the Soviet attempt to break the power of the *shamans*.

Yet the most direct impact of the Soviet system upon the natives was by way of the economic reorganization introduced as soon as Soviet power was established. Every attempt was made to widen the scope of existing trade with the natives, which had hitherto been mainly restricted to fur; production of reindeer meat, fish, hides, and other articles was encouraged by the trading-posts, which were increased in number. The introduction of Soviet training methods was less easy and less successful. Private trading was hard to abolish. The Soviet authorities were wise enough to see that direct administrative action would only unite the natives against them, and so they went about the change gradually. The so-called 'integral co-operatives' were set up in 1927. They were a method of co-operative trading which took into account the special features of trading with primitive peoples, in that they exchanged a variety of native products (rather than just one line) for the necessities of life, and provided facilities for helping natives to produce more by use of improved methods in their hunting or reindeer breeding, or to enlarge their sphere of action by encouraging such innovations as agriculture and stock-farming.

It was in this way that the collectivization of agriculture started to become effective in the Arctic. At first there were evidently some excessively zealous attempts to introduce full-scale collective farming. These, it seems, were so violent and so little successful that the order was given to proceed slowly in the far north, and to organize only simple producers' co-operatives. As time went on, however, collectivization on the Russian model was introduced. Reindeer collective farms are the most common in the Arctic, though maritime peoples are also organized into fishing collectives. The existence of the collective made easier the introduction of other, subsidiary, industries: in the case of a nomadic reindeer-breeding community, a centre was chosen at which members of the group not actually herding the deer – women, children, old people, and any young men not needed – remained behind while the herd went off in search

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of pasture. It was among this group that it was possible to get other activities going, such as dairy-farming, fishing, or fur-farming. By 1940 it is said that 75 per cent of households in the far north were collectivized. The percentage varied considerably from area to area; in the Evenki National *Okrug* it was 98 per cent, while in the Chukchi National *Okrug* it was 42 per cent. The process of collectivization is still continuing since the war; from articles in the Soviet press in 1951 it is clear that the change-over to collective farming had only just been made in some places. There can be little doubt that the change has brought about an increase in the products available for outside use. This does not necessarily mean that more is produced per head of the population by collective methods; it means that in dealing with a collective farm rather than with widely scattered individual households the Soviet authorities can see just how much is produced and market whatever they believe to be surplus to local needs.

It is worth mentioning that collectivization in the Arctic has been made to serve another end besides that of increased production: like the local Soviets, but on a larger scale, the collectives are deliberately arranged to cut across clan structure, bringing members of different clans and even of different tribes into the same collective. This is another way of breaking down the tribal social structure.

According to Soviet assessments made since the war, the results of Soviet policy towards the natives, as outlined above, are these. On the economic side, use of better rifles, harpoons, and boats has led to better hunting returns, while veterinary care has improved reindeer herds – there is better performance, in fact, of the main occupation of most natives. The introduction of new means of gaining a livelihood has led to considerable change in the economic basis of some tribes. For instance, among the Kety, Dolgany, and some Nentsy fishing now takes first place to reindeer-farming or hunting; among the Chukchi, Koryaki, and other tribes in the north-east reindeer-breeding has spread. Secondary industries which have been encouraged include berry- and nut-picking, making shoes, clothes, and

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blankets, boat-building, other carpentry work, and carving, especially in bone. The introduction of farming (other than reindeer-farming) affects most of the tribes in some degree, but particularly the Khanty, Mansi, Evenki, and some tribes on the lower Amur. Because a greater range of products is marketed by the northern peoples, their economy is more closely linked to that of the U.S.S.R. This has meant a wider use of money and less bartering. Money wages are now paid to collective farm workers, hunters, and so on, and in some cases quoted these are high.

On the educational and cultural side, it is claimed that many nomads have now settled (though only an undefined part of most tribes; the Ude and Oroki, two very small tribes on the lower Amur, are the only groups said to have settled completely). The absorption of Russian culture is seen as something wholly good; instances quoted are certain foodstuffs, clothes, household furniture, especially the Russian stove, the dwelling itself (the Russian peasant's *izba*), and the native languages, which have acquired many Russian words. The effect of the medical aid has been to arrest the decline in population; by 1937 most of the tribes were 'significantly rising' in numbers. And finally, the tradition of many tribal customs has been broken. The total effect therefore is that the northern tribesman is reckoned to be fast becoming a useful Soviet citizen, and to prove this point cases are quoted of exploits by individual natives in the Red Army during the war.

All the information quoted up to now in this chapter has been directly or indirectly culled from Soviet sources. It is therefore based on the official version that the Soviet Government wants to have publicized, at least as far as the main trends are concerned; since in everything of any importance only the official version gets published. One may wonder how far the official version is in fact the true version. It may of course be wholly true; but there is enough evidence on other topics to show that the Soviet official version of events is not always wholly true. It is unlikely to be wholly false, or that would imply that a number of Soviet anthropologists and ethnographers

were employed inventing facts about native peoples, and anyway falsity on that scale would be recognizable as such by too many people. If it is wrong, it is likely to deceive more by omission and misplaced emphasis than by wholesale distortion of facts and figures. In testing the truth of a Soviet statement the best evidence to use is that of the independent, uncensored observer. But there is almost no evidence of this sort, because independent observers practically never get to these parts of the country. Evidence is only what can be read between the lines of the Soviet literature, and what can be deduced from knowledge of Soviet policy towards other national minorities.

Let us consider first the Soviet system of administration, which, as we have seen, is designed to ensure that national minorities, no matter how small, can run their own affairs. Each national district, whether Autonomous Republic (as the Komi and Yakut) or a lower form of national autonomy, elects its own local councils and sends its representatives to the Supreme Soviet in Moscow. The local organs of government deal with local affairs, the central government with national affairs, such as foreign policy and defence. This sounds quite straightforward on paper, but there are other considerations which in fact make the reality of local autonomy a shadow of what it is made out to be. For real power in the Soviet Union belongs not to the bodies mentioned in the Constitution, but to the Communist Party. The assemblies, committees, and Soviets listed on paper do exist and do function, but only because the Communist Party wills it and provides the key men who make them work. And the Communist Party is extremely centralistic, the Party machinery being designed to ensure that the remotest branch carries out selflessly the will of the Praesidium of the Central Committee. Even the supreme legislative body is without any real power. The Soviet of Nationalities, which is part of the Supreme Soviet, and to which the northern peoples send deputies, is a body in which non-Russians are in the majority. On paper, therefore, the minority peoples could prevent the passage of very important legislation. But in practice the Supreme Soviet meets twice a year for a week each time,

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during which it approves decrees already issued, and in any case all the deputies are selected before election by the Communist Party. The northern peoples therefore have no guarantee, in spite of the legislation appearing to prove to the contrary, that they will be able to influence their own destinies. Their only hope of doing this will be to influence, by becoming members of, the Communist Party; but even then they will be permitted to improve their own national lot only if Moscow decides that it will be advantageous to the Party as a whole if they do so. The complete power that the central government has over the national minorities cannot be better illustrated than by quoting the war-time experience of five autonomous territories, the Volga German, Crimean Tatar, and Kalmuck Autonomous Republics among them, which were abolished by a stroke of the pen and their inhabitants dispersed. Suspected disloyalty was the reason for this. Such extreme measures have never been taken in the Arctic, but perhaps this is because the loyalty of the northern peoples has never been put to such a severe test.

It is quite clear, then, that national autonomy among the peoples of the north is a fiction. This does not mean at all that the natives are deliberately maltreated or neglected; the Communist Party is undoubtedly sincere in its desire to better their conditions. Indeed, accounts by escaped prisoners from arctic labour camps give the strong impression that the natives are in many ways pampered by the Soviet authorities. Much is provided for them in the way of material help, and many privileges are granted them, such as freedom from taxation and military service. Anyone convicted of 'exploiting' a native is likely to be heavily punished. But it does mean that whenever there is a conflict of interests – which is likely over most important matters – the Russian view rather than the native will prevail. If for instance minerals are found in native territory, their mining and marketing will be carried out entirely under arrangements made in Moscow. Of course the tribesmen would be quite unable to undertake anything like this by themselves and outside help is entirely justified; but one would expect them to

derive some benefit from the development of wealth found in what is after all legally their own soil, and this not so. The Nentsy at one time thought that their National *Okrug* was really their own, that they could govern it as they liked and exclude anyone they did not want. This 'nationalist deviation' was energetically fought by the Communist Party.

The native is also in danger of being submerged in the tide of Russian immigration into his land made necessary by Russian decisions to undertake this or that mining or construction job. The small numbers of the northern peoples make the danger especially great, for only a moderate inflow of alien stock is required to endanger their national survival. In fact the inflow has in many cases been very great. The mining towns in the Murmansk region, the Pechora coalfield, the lower Yenisey valley, the Kolyma-Indigirka area, and the port settlements along the Northern Sea Route are all islands of predominantly Slav population, outnumbering by many times the natives in the surrounding countryside. It is hard to see how these places can fail to become the administrative, cultural, and commercial centres of their localities, radiating Russian culture and regarding the natives rather as museum specimens, interesting and worth preserving, but certainly not to be thought of as the most important people, politically speaking, in the region. If that is the case, then it can only be a matter of time before the national culture is obliterated by Russian culture.

Yet perhaps this is putting the problem rather too simply. Clearly some contact with Russian culture is quite inevitable, and indeed desirable. This is apparent in problems of education. The facts of geographical location make it necessary that a member of a small linguistic group surrounded by speakers of a more developed and much more widely used language should learn that language. A Breton will not get on unless he learns French, or a Gaelic-speaking Scot unless he learns English. So it is quite obvious that the Russian language will be useful to the northern natives. Knowledge of that language will also bring him into contact with a culture which is incomparably richer and more diverse than his own; it will

make him aware – if only dimly, in present conditions – of world trends of thought, of science, and of a hundred other things that his own language could never possibly give him. There is therefore nothing unreasonable about a Soviet educational policy which teaches the natives Russian (using their own language in order to do this), and then in the later stages of schooling goes over to teaching in Russian for subjects which the native language has not got the vocabulary to express adequately. This is what the Danes do in Greenland, and the other Scandinavian countries in Lapland. Indeed, there would be justifiable cause for complaint if knowledge of Russian were withheld from the natives, for then it might be supposed that there was a deliberate attempt to deprive them of access to the world's knowledge and to keep them in a state of barbarism. So knowledge of Russian should benefit the natives; but only if every care is taken to ensure that their own language, and therefore culture, does not suffer as a result. It is here that there seems to be cause for alarm.

A conference of Soviet linguists discussed in 1952 or 1953 the application of Stalin's excursion into linguistic theory – his pamphlet *Marxism and Questions of Linguistics*, published in 1950 – to the problem of development of the northern languages. It was urged by speakers here that Russian words and phrases should be introduced wherever no adequate native word exists, because this would make the learning of Russian easier for the natives. The importance of also developing the native languages is not denied; but the reason for this is seen to lie in the fact that it will then be all the easier to teach the natives Communism; and that 'literacy in their native language helps the peoples of the north to learn Russian, to be linked more fully with the great Russian culture, a goal persistently sought not only by all the peoples of the Soviet Union, but by peoples of many foreign countries'. If this is to be the reason for studying and perfecting the native languages, it is only a step from here to permitting them to lapse entirely and be replaced by Russian. There is other evidence pointing to the same trend. A post-war description of the development of a collective

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farm in the Taymyr region states approvingly that the members of small tribes living in the vicinity – the Entsy are mentioned in particular – are losing their individuality and are being ‘consolidated’ into the dominant tribe in the area, the Nentsy. Here again there is clearly no wish to stop a process which could lead to absorption of the small nationalities by the larger, and therefore in the long run by the Russians. The deliberate breaking up of tribal custom is likely to have the same sort of effect also. A paper outlining the marriage rites used among the Kety until recently gives the general impression that this small group is becoming merged into the mass of Soviet citizens, although they are still regarded as a separate people and are still called Kety.

The Danes have the same problem in Greenland, and the Canadians in their own Arctic. The Soviet Government, on the kindest estimate, regards its duty towards the natives as a matter of attending to their material well-being, no doubt because Marxism sees economic factors as the fundamental determinants of human behaviour. But here is the Canadian Minister for Northern Affairs, who is responsible for administering the country’s Eskimo population, writing in the spring 1955 issue of *Beaver*:

‘The only realistic approach is to accept the fact that the Eskimo will be brought even more under the influences of civilization to the south. The task, then, is to help him adjust his life and his thoughts to all that the encroachment of this new life must mean. . . . Adjustment to our way of life must be related in character, time and degree to the developing situation in each area, *provided it is made quite clear that adjustment does not mean the loss of the identity of the Eskimo’s culture.*’ (My italics.)

This shows an attitude that one looks for in vain in Russian writings. For Soviet Russians it is axiomatic that Socialism, coupled with the brotherly help of the Russian people, brings immeasurable benefits, and concern about loss of identity of a people’s culture comes a long way behind, if it comes at all.

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The Danes are even more aware of this danger. Their handling of the native population in Greenland has been generally acclaimed a model of how a primitive people may be assisted and yet shielded from harmful influences.

It is very difficult to judge whether the economic reorganization introduced under Soviet rule is as successful as it is reported to be. The glowing reports of life on a reindeer collective farm may be true; but they do not mention how widespread this happy state is in the north, or what happened while collectivization was being introduced. It is common knowledge that the collectivization of farms in the main agricultural regions of the country was often accompanied by extreme violence. This is less likely to have been the case in the north because distances would have made coercion more difficult. But it is not likely that the natives will have permitted a radical alteration of their way of life without protest, and the Russians admit, as we have seen, that early attempts at collectivization were failures. It is clear that concessions have been made to collective farmers recently; for instance, the number of reindeer permitted to be privately owned by members of a collective farm is now as high as 130 in some areas. This seems to indicate that the principle of working for the collective because that is the fairest and most profitable way of organizing labour is being replaced by the principle of working for the collective because it is the best way to establish yourself outside it. The success of the policy of settling nomads (on which their subsequent collectivisation depends) is also open to some question. There are Soviet accounts which show that some settled nomads have returned to nomadism after a while. One cannot however judge how important this trend may be.

The general picture which emerges, then, is something of this sort. The native peoples of the Soviet far north have had much done for them on paper; and even if the reports are not entirely reliable, it is clear that they have benefited in material things to a very considerable extent: medical and veterinary aid, better equipment for gaining their livelihood, better organization of food supplies, facilities for education. But if

they have gained materially, they have lost spiritually. For their future existence as distinct nationalities, at least in the case of the smaller groups, is threatened by the loss of any real right to self-government, and by a tide of Slav settlement which is free, as far as the Soviet authorities are concerned, to inundate them.

Some idea of the effect the Revolution has had can be got from comparing two accounts of the same tribe before it and after it. The Chukchi were studied very carefully over a period of years by the Russian ethnographer Vladimir Bogoraz. Writing at the very beginning of this century, he comes to the following conclusions about the relation between Russians and Chukchi.

‘The Russianization of the Chukchi has made no progress at all during the centuries of Russian intercourse with the Chukchi. The Chukchi kept the language, all their ways of living, and their religion. Even the few families of the river Chukchi of the Middle Anadyr’ have not adopted the Russian language. They have adopted the Russian chimney on their huts; and under Russian influence there have sprung up among them riddles and proverbs, partly translated from the Russian, and of a character different from that of the other folklore of the Chukchi; and that is all.

‘As to the question of what was brought into the life of the Chukchi through Russian influence, I should say that the first thing brought by the Russians was a request for tribute and war. The fate of the Chukchi, however, was different from the fate of all other native tribes, in that they successfully repelled the first, and held their ground in the second; and, when the war at last ceased, they preserved intact all their national vigour, and so they could avail themselves of peace. This explains the spread of the Reindeer Chukchi westward and southward, and the subsequent increase of their herds.

‘In modern times, the same as two centuries ago, Russianization for this nomadic and primitive people would mean

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destruction and death. It is their good fortune that the latest contrivances of the Russian Administration, like the "clans" and the "chiefs", and the voluntary tribute, are mere outward forms, and do not produce much change in their material or special life.

'Russian influence has brought to the Chukchi tools and instruments of iron, flintlocks and powder, iron kettles, and hardware. These are real acquisitions. Coloured beads, and overcoats of gaudy calico, are also to be counted among such acquisitions, since they satisfy the aesthetic sense much better than the corresponding native objects. I wonder whether such a thing as a calico shirt should also be added to the total number of useful innovations. Even the Russian creoles use a single shirt without change, and keep it on their backs until it drops off in old greasy rags. The Reindeer Chukchi occasionally put on an old shirt bought from the Russians. They call it "louse-catcher", and assert that its chief purpose is to attract the lice from the skin, so that they can be easily destroyed.

'Along with all these acquisitions were also brought contagious diseases, alcohol, and card-playing, and their influence certainly equals that of the newly introduced inventions. . . .

'From all that has been said, the general conclusion may be drawn that the Chukchi tribe, Reindeer or Maritime, being very primitive, may continue to exist in its barren desert only if left alone by civilization. As soon as the latter comes too near, the Chukchi must follow in the way of so many other primitive tribes, and die.'

Contrast this with a book which describes life among the Chukchi in about 1934. It was written by a man who was himself a school teacher in the first boarding school in the region, Tikhon Semushkin.

A Russian teacher returning to her school in Chukotka reads a letter she has received from her pupils while she has been away on holiday.

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‘Hello, Tanya-Kay!

‘We send you warm greetings. We got the parcel and thank you very much for it. In the autumn, when we got the parcel, we sent off a telegram at once but as we can see from your letter it got held up somewhere in the mountains.

‘Life in Chukotka is different from what it was. Real cinema operators have arrived. They show good pictures almost every day.

‘In Provideniya Bay there are preparations for building a sea port. They say this will be our big town.

‘In March there was a regional conference. We heard the report of the Secretary of the Regional Committee of the Komsomol, Comrade Ukhsima. You remember her, the Eskimo girl from Chaplin? Plenty of Komsomols took part in the discussion. One of the instructors of the Regional Committee, Comrade Kalyau, was sacked. They said his practical work was weak.

‘We have been working at the history of the Communist Party from textbooks. In far-off Chukotka we hear the loud voice of the Union of Soviet Socialist Republics.

‘In the pages of the newspaper *Sovetskiy Uelen* we read the latest news. We send them our poetry, and they print it . . .’

There is no ambiguity about the Russianization here. Almost every line shows another Russian influence. And there can be no doubt at all that this picture shows the results of a quite deliberate Soviet policy. The words of Bogoraz seem about to be proved true: ‘as soon as civilization comes too near, the Chukchi must die’. Perhaps it will not be in the literal sense, for the Soviet regime has brought practical advantages which should improve, and not lessen, the chance of physical survival. But as a separate national entity the end may not be too far removed.

Such a prospect may sadden only the sentimentalist; but the loss will be deeper than that. A national culture – the way of life of a people, evolved through the centuries – is a contribution to the world of infinite value, for when it has disappeared nothing can replace it.

CHAPTER SEVEN

Arctic Archaeology

The word archaeology makes one think of the remote past; because archaeology, the study of history from man-made objects, is the only way to find out what happened before people wrote things down, or more exactly in cases where their writings cannot be found. But in the Arctic it can take on a rather different character, for it is quite often the only way to discover the events of the fairly recent past, and this among literate peoples. A few shreds of sailcloth and the remains of a fire may provide the missing link in some saga of exploration.

Among the many expeditions working in the Soviet Arctic just before the U.S.S.R. entered the war, there was one which was particularly memorable in this connexion. It made some discoveries of great interest, and, as so often is the case, made them when the expedition was working on something totally different.

Charting was given a high priority at this time. The *Nord*, a small vessel used for hydrographic surveying, was sent to study the behaviour of the waters in winter off the east coast of Taymyr. In September 1940 a mapping party of four men left the ship and landed on a small island just off the coast, the most northerly of the group called Ostrova Faddeya. While they were making their survey, one of the men noticed part of a copper pot sticking up out of the ground. No particular attention was paid to this, because the men knew that Roald Amundsen, the Norwegian explorer, had wintered round here in 1918-19, and they thought any camp litter would be his. But curiosity got the better of them and they returned to the spot to investigate. They found pots and pans, an axe, a pair

of scissors, and some beads. The Amundsen idea did not seem to fit now, because there were no empty tins of food, and anyway the things seemed much too primitive in design. They finished the survey and went back to the ship.

Their report must have been found interesting, for a few days later a larger party came back to the island with instructions, among other things, to search the site again. This time many more objects were found: among them tin plates, coins, earrings, crosses, rings, and an ancient pistol. The party was now fully aware that they had found something important, and wisely desisted from further digging, 'since by our inexperience we might have done it wrongly'.

In the spring of the next year, 1941, parties went out again from the ship, which had been wintering at Mys Faddeya, a cape some miles away on the mainland. One followed the coast of the mainland westwards in search of firewood. On the shore of Zaliv Simsa, about forty-five miles from the ship, they found the remains of a small hut. Snow lay everywhere, and the ground was too hard to dig, so it was decided to come back later in the year. Accordingly, two mapping detachments went there at the end of June, and the first man to reach the hut at once noticed on the ground a pot like those found on the island in the autumn. The site was searched, and a large number of things were found. Many turned out to be similar to those already recovered from the island – pots, coins, crosses, rings, and so forth. Others were new – a compass, pieces of cloth, tinder and flint, animal and human bones, part of a document inside a knife-sheath, and many other things.

All these objects were brought back by the expedition when it returned in the autumn, and many of them were put on show in the Arctic Institute. Quite clearly the finds were of very great interest for the light they could throw on the early exploration of the region – a subject on which virtually nothing was known. They were evaluated by an expert, B. O. Dolgikh; but the situation was unsatisfactory because the expert must be familiar with the site if he is to draw all the deductions he should, and of course none of the expedition knew anything

about archaeology. If the detective cannot go to the scene of the crime, but has to rely on what other people tell him, he will probably miss the important clues and come to the wrong conclusion. So it was decided to send an archaeological expedition to the region as soon as it could be arranged. This was done in 1945, and it was led by A. P. Okladnikov, the acknowledged authority on the archaeology of northern Siberia. His party made a detailed search at both the sites, and, as one might expect, found many more things. On his return Okladnikov wrote a learned monograph describing the finds and drawing his conclusions from them; but this seems never to have reached western Europe. He wrote a shorter and more popular version before he finished the other, and this we do have.

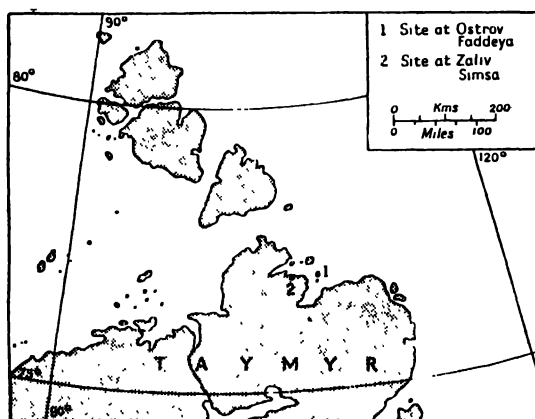
The story of the expedition to which these remains bear witness was pieced together by Okladnikov. The first problem – when did it take place – fortunately had quite an easy and reliable answer: the coins. These were very numerous – there were over 3,300 – and they came from the reigns of seven rulers of Moscow covering the period 1533–1645. The numismatist who examined these, I. G. Spasskiy, was able to conclude, on the basis of the relative quantities of coins from different reigns, that the money was collected definitely in the first quarter of the seventeenth century, and was even prepared to give 1617 as the most probable year. So that was the date, within a year or two, of the expedition's start. All sorts of other items found confirmed this date within wider limits: the design of the axes, to quote only one instance.

The nationality of the party was the next question. One might imagine that the coins made this clear. But there is plenty of historical evidence that Englishmen and Dutchmen had been sailing in north Russian waters about this time and a little earlier. So it was necessary to show beyond all doubt that the expedition had been Russian. And in fact there were plenty more indications that this was so: the style of the clothes and footwear (deducible from scraps found), the crosses, which were of the sort worn round the neck by members of the Russian Orthodox Church, certain characteristically Russian items

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of equipment, and, most significant of all, writing in Russian on the bit of document and on the handles of knives. It may be taken as certain that this was a party of Russians. Some of the objects have led to the suggestion that there was a woman with them, and that she was a native woman. But this is not much more than guesswork.

How did they get there? The two sites, which are about fifty miles apart, are extremely remote. At that period the nearest Russian settlement was at least 750 miles away in a direct line, in the lower Yenisey region. The mainland site was on the edge



Map 6. The archaeological sites investigated in 1941 and 1945.

of the tundra, and might perhaps have been reached occasionally by nomads following their reindeer herds to summer pastures, but certainly by no one else. The actual position of the sites, each within a few yards of the sea-shore, points to arrival by sea; and this is confirmed by the discovery of the remains of a boat on the island, and of several instruments used for navigation at sea. So it may be reasonably assumed that the party came by sea. The question now arises, did they sail in from the east or from the west? The answer to this obviously depends on what can be discovered about the object of the expedition.

Once again they left enough behind to provide something to star arguing from. A number of traps and arrow-heads of a

special type shows that there was the intention of hunting animals for their fur. And the glass beads, metal rings, and other trinkets, together with a spring balance, indicate trade with natives. Furthermore, from the quality of the articles found, and the amount of money, it would seem that these men were people of substance, leading personalities in their line. They were professional traders who knew the market.

This being the case, more light is thrown on how the party might have reached the area where the remains were found. The animal for whose pelt they were looking must have been the sable, which was at that time the source of almost all the fur which came out of Siberia. There was no interest then in the arctic fox. The sable is found only in the valleys of the big rivers – the Ob', the Yenisey, the Khatanga, the Olenek, the Lena. It is not found further north in the tundra. The same, roughly speaking, is true of the native peoples. The northern part of Taymyr is certainly not the place to look for native settlements, and anyone familiar with other parts of the Eurasian Arctic would realize this. The party must have been on its way to one of the valleys. Was it going towards the western rivers (Ob' and Yenisey) or the eastern (Olenek and Lena)? If it was going round Taymyr towards the west, then it must have come from the Lena or another river in the vicinity, or else have cut across the base of the Taymyr peninsula. There are arguments against both possibilities. The Lena region is an unlikely starting point, because the Russians in their advance across Siberia did not establish settlements there until 1632, or fifteen years after the supposed date of this expedition; there would not therefore have been any base from which an undertaking as large and adventurous as this one might have been launched. It is also unlikely, but perhaps not to the same degree, that the party crossed the southern edge of Taymyr. The main argument against is that there would have been little point in heading in that direction if one were in search of sables or natives. Also, of course, there are no reports of anyone taking that route as early as this. But this argument is not strong, since records of any sort are very scant; and in any case this

party, from which probably no one returned, might have been the first.

By process of elimination the conclusion is thus reached that the expedition was sailing from west to east. If this is so, it had probably come from Mangazeya, a trading centre founded in 1601 on a tributary of the river Taz, between the Ob' and the Yenisey. It was from this remote Arctic outpost that the Cossacks fanned out in their rapid advance through the northern forests. Okladnikov says that it 'can scarcely be doubted' that this is what happened. He may be putting the probability a little too high; but he clearly has a strong case.

The various objects and pieces of equipment found have all been examined by experts in each particular subject: the sledge remains, the fishing-tackle, the knives and gun, the ship itself. The discovery of chessmen led one writer to put forward a suggestion – he did produce some additional evidence – that chess was introduced among the north Siberian natives by the Russians. The examples of decorative art – the rings, crosses, and earrings – were shown to be of the type found in the Arkhangel'sk region of north Russia at the beginning of the seventeenth century. One particularly striking item was a bronze mirror, about ten centimetres in diameter, with a finely wrought design on the back representing a winged centaur. It was evidently intended that this should be used for trading with the natives; for the winged centaur was a favourite subject in Russian folk art in the fifteenth and sixteenth centuries, and bronze mirrors or medals with this design have been found in the possession of various native peoples across the whole width of Siberia from the Urals to the Sea of Okhotsk. The sun-compasses, found both on the island and the mainland, are interesting evidence that Russian sailors of this time did know something about navigation. It had been held before by most authorities that Russian seamanship relied more on luck than anything else.

The consecutive narrative, then, as far as it has been – and probably can be – reconstructed, is this. In about 1617 a party of some ten men left Mangazeya in a *koch*, a shallow-draught

sailing-vessel of those times, and set off on a trading trip of the kind they had often done before. But this time they went further afield: they coasted round Taymyr, passing Mys Chelyuskina, the most northerly point of the Eurasian mainland, but were forced to winter not far beyond that point, in Zaliv Simsa. Here a small hut was built. After the winter, during which they lived largely on arctic fox (witness the bones found), the party split up. Some remained at the hut and died there, probably of starvation; some took the ship when the ice had cleared, reached Ostrova Faddeya, and died there, possibly of starvation or by drowning.

The significance of all this in the history of exploration is considerable. The only surviving accounts of early voyages north of Scandinavia and Russia concern the English and the Dutch, who were attempting to find the North-east Passage to the riches of Cathay. None of them succeeded in getting further east than the western part of the Kara Sea; most did not get that far. But many of their accounts tell how they met Russian ships in this region and learnt much from their crews. It was clear that the Russians sailed frequently in these waters, that they knew well the sea route to the Ob' and possibly beyond. The western histories do not mention any sea voyages beyond the Ob', but they record the existence of another large river – the Gilissy, which is the Yenisey – and of a promontory beyond it called Tabin, or Taymyr. So these places were known about. First-hand Russian accounts of all this, which might have been so informative, have never been found and were probably never written.

The first record of ships sailing in the waters beyond the Ob' belongs to the time of Catherine the Great, over a century later. A large exploring expedition, known as the Great Northern Expedition, was in the field for ten years, from 1733 to 1743. The greater part of the north Siberian coast was then mapped. Lieutenant Fedor Minin sailed up the west coast of Taymyr as far as 75° north, and Lieutenant Khariton Laptev on the east coast reached almost the exact point at which the finds were made in 1940–1. There was a gap of about 500 miles between

the two; and that stretch, which includes Mys Chelyuskina, was never navigated by members of the Great Northern Expedition. However, the cape itself was reached on foot by the indomitable Semen Chelyuskin of that expedition. No one succeeded in reaching the cape by sea until 1878, when the great Swedish explorer and scientist Adolf Erik Nordenskiöld sailed past in the *Vega* and altogether justly named it after Chelyuskin.

If we accept Okladnikov's version, then, Nordenskiöld's achievement was preceded, at a distance of over 250 years, by perhaps a greater one – for a Russian *koch* of the early seventeenth century was very different from the *Vega*, with her three masts, steam engine, and specially strengthened hull. Further, the filling in of the gap on either side of the northern tip of Asia means that Russian seafarers navigated the whole length of the north Siberian coast before any non-Russian.

This last point does not seem very important to us who are not Russian, but much is made of it in Okladnikov's book. Nationalism is a feature of the book, as it is of the whole contemporary Soviet scene (and perhaps it would be wrong to blame the author for this). The merits of Russians are everywhere extolled, if possible at the expense of other nationalities; but not at the expense of the Siberian peoples. Inferences are drawn from the story of the expedition to show that the relationship between Russians and natives was healthy, each side learning from the other. No mention is made of the trading with glass beads; one can easily imagine what that would have been used to prove, if the circumstances had been different. However, one has to remember that with the Soviet Union in very nationalist mood every achievement of Russians in history becomes especially noteworthy. And in this case it was no doubt particularly galling to know that Russians very likely did distinguish themselves, and yet there was no evidence to prove it. In any case, we must not allow the remarkable feat of this little group of unknown trappers and traders to be in any way belittled.

This problem of the Taymyr finds has provided a neat, compact little subject for study. The opportunity, once offered, was

grasped enthusiastically; no effort was spared, a first-rate man was put in charge, and the result was a piece of research which did credit to everyone concerned. One may guess that the enthusiasm was not solely due to a disinterested love of archaeology; but that does not seriously affect the result. This was a problem in which, for once, there was enough evidence to give an archaeologist a good chance of coming to some conclusions. All too often there are simply not enough objects found. There have been one or two recent discoveries of this tantalizing sort in the Soviet Arctic.

In 1944, for instance, a worker at the Kamchatka fisheries went on an excursion into the interior of that remote land of volcanoes and snow. On the shore of Lake Ushki, which drains into the Kamchatka river some 125 miles from its mouth, he found among the rocks four small copper coins. These he showed to a numismatist in Kamchatka, who could make little of them. They were sent to the experts in Leningrad, and the answer they gave was really rather astonishing. Two turned out to be coins from the Greek colony at Panticapaeum on the Black Sea; one of them minted in the third century B.C., and the other in A.D. 17. The other two came from the ancient kingdom of Chorasmia on the river Oxus in Central Asia, a centre which flourished until the Middle Ages. These two have not been dated. There is no indication whatever to show how these four pieces of money might have reached the spot at which they were found, distant between 4,000 and 5,000 miles in space and up to 2,200 years in time. Did the ancient Central Asian trade routes spread even further than we suppose? Or did some coin collector drop them from his pocket a decade or two ago? Perhaps the answer will never emerge; or perhaps the find will be the first clue towards the discovery of some quite unknown early voyage.

While the presence of Greek coins in Kamchatka may give rein to the fancy, and encourage the wildest speculation, another recent discovery comes within reach of solving a particular problem of the recent past. In July 1947 the scattered remains of a human skeleton, together with traces of a camp

fire, five empty food tins, and some pieces of board that seemed to have come from a boat, were found on the north-east coast of Ostrov Bol'shevik. This island is the most southerly of the group called Severnaya Zemlya, and their discovery in September 1913 was the last major discovery of land within the Arctic Circle. What tragedy had been uncovered here?

The short history of the islands' exploration gave no clue. Of the few parties which had been there, none had lost a member. It could not have been a native; for a variety of reasons, of which the chief is that natives never go there. Earlier exploration in the central part of the Russian Arctic did not give much of a lead either. Those who had been lost could not possibly, for one reason or another, have reached Severnaya Zemlya. The tins prevent one going back to the days when expeditions could have taken place without anyone knowing anything about them.

By process of elimination, one finds that only one expedition could have been at this place at this time. That was a party led by the Russian geologist V. A. Rusanov. He had taken part in several Arctic expeditions, and he set sail in 1912, with his French fiancée Juliette Jean on board as doctor, in an attempt to traverse the whole length of the North-east Passage from Atlantic to Pacific. Leaving a note explaining his intentions on the island of Novaya Zemlya, he headed eastwards and neither he, his crew, nor his ship were ever seen again. His disappearance remained a complete mystery for twenty years. Then in 1934 a post with the name of the ship inscribed on it, with the date 1913, was found on a small island off the west coast of Taymyr. The next year assorted objects, which could be proved to have belonged to members of the expedition, were found on the beach of another island not far away. All this led to the supposition that Rusanov's ship had wintered in this part of the Kara Sea, and had then probably been crushed. But the new find could point to the fact – although there is not a shred of evidence for it yet – that the ship reached Severnaya Zemlya; and since the discovery of this last remaining land-mass was made in late August of 1913, perhaps Rusanov was



(b)

13. (a) A Knife, (b) a sun compass, and
(c) some chessmen found at Taymyr
sites. (Drawings by V. D. Zaporozhskaya.)



(a)



(c)

even the first to sight it. This much at least is clear: whoever possessed the skeleton found in 1947 was the first human being to set foot in that particular part of the archipelago, for no known ship, sledge party, or aircraft had ever visited that place before. Sooner or later we ought to be hearing about this. For there is bound to be more searching for clues in Severnaya Zemlya, and if Rusanov's party did get there, they will certainly have left other traces behind them.

Perhaps we are getting close to the point at which archaeology shades off into the science of detection. But the name does not matter. Signs of unsuspected human activity in very remote places will always be interesting, and it is just as well that there should be people practised in reading them.

CHAPTER EIGHT

The Siberian Mammoth

There is something romantic and rather frightening about mammoths. Everyone has seen children's history books in which Chapter 1 is embellished with a most exciting picture showing Stone Age man attacking a shaggy, ferocious-looking brute of enormous size, whose gleaming tusks are making short work of attackers who come too close. The word itself has come to be used as an adjective. We have all seen, too, reproductions of the earliest known drawings and paintings; those found on the walls of caves, particularly in France and Spain. Here mammoths were frequently depicted, in the most striking and skilful manner; and this is some of the evidence, of course, on which the imaginative book-illustrators base their compositions.

Mammoth bones, not recognized as such at the time, have been the object of incredulous interest up and down Europe. They were thought to be the bones of giant humans. Some were even venerated as the remains of saints; several churches and monastic houses in Germany and France treasured them as relics. In Siberia the Yakuts had found comparatively complete remains of mammoths buried in the ground. This made them think it must have been an animal which lived underground and died when it came up to the surface. In fact the word mammoth is supposed to be derived from a native word meaning earth. The Tungus (now called Evenki) are nomads who cover, as a tribe, a vast area of Siberia. Mammoth remains were found sufficiently often in their region for there to be a word for the animal in their language; and any sort of contact with the remains, even seeing them, was thought to have an evil influence. The Chinese also knew about mammoths by

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hearsay from their neighbours in Siberia, and in this way written records came into being.

It was some time before the fabulous mammoth lost his saintly or his subterranean attributes and became the simple, honest *Elephas primigenius* Blumenbach; but when he did, it was from Siberia that much of the knowledge came. Owing to the permanently frozen soil, not only the bones but also the flesh of some mammoths was preserved. In fact some beasts were discovered in remarkable condition, and a good deal came to be known about their appearance and habits. This knowledge detracts a little from the picture-book idea of mammoths; for they were not so terribly large – generally smaller than elephants of today – and were strict vegetarians. But for all that they must have been an imposing sight; and the cave drawings show clearly enough what a deep impression they made upon our ancestors.

The mammoth was a creature of the Pleistocene period, which began a million years ago and ended 25,000 years ago. In the form in which we know him he belongs to the end of this period. His range was very great, for he wandered over Europe and Asia from Spain to the Bering Strait, and was known in North America as well. He was prolific, too, for a large quantity of his remains have been found: the historian Yuri Semionov says that in two centuries 22,000 were found in northern Siberia alone. The curiously curved tusks, up to ten feet long and well over 100 lb. in weight, were of value; for the ivory found a ready market elsewhere in Asia and in Europe. China had been an importer of mammoth ivory since mediaeval times, and much was used in western Europe. No doubt the figure of 22,000 is arrived at by calculation from the merchants' returns. Certainly for many years before the Russian Revolution about twenty tons of ivory found its way to the fair at Yakutsk every year. For plenty of natives this hunting for prehistoric remains was just as important a means of livelihood as hunting live quarry. The search took them to the furthest corners of Arctic Siberia; they even struck out from the north coast of the mainland across the ice of the Arctic Ocean to the

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group of islands called Ostrova Novosibirskiye, and here they found one of the richest hunting grounds for tusks.

The mammoth always favoured rather cold climates. He was about during some of the Ice Ages, and followed the ice northwards when it retreated. The reason why so many well-preserved specimens have been found in Siberia is that the temperature of the soil has in many places never risen above freezing point from that time to this; the animals fell down crevasses, or into pot holes, or got stuck in the mud in marshy land (mud would form in the summer on the surface), and were quickly frozen. They are exposed again either by melting of the ice in exceptionally warm summers, or by the washing away of river banks or the sea-shore.

Of the large animals which roamed Siberia perhaps 30,000 years ago, only one contemporary of the mammoth remains: the musk ox. This buffalo-like creature is now to be found only in Greenland and some of the Canadian Arctic islands, where he is protected by law from extermination at the hands of explorers who are anxious to lighten their loads of food by living off the land. He used to live in Siberia, however, for his remains have often been found there.

Perhaps the most imposing of the mammoth's Siberian contemporaries was a relative of the rhinoceros, who has never had any other name but *Elasmotherium sibiricum* Fischer. He was nearly as large as an elephant, and had two horns on his forehead: one large and one small. According to the legend of some Siberian tribes, this imposing animal was ridden by the giant of the ice, the sight of whom meant death to the beholder. His great horn has been suggested as a possible origin of the unicorn. His skull, seen from the front, is said to resemble a horse's, and since he wandered as far south as Persia, the early Persian ideas of horse-like unicorns may have been inspired by him. It is alleged that Haroun-al-Raschid, the Sultan of Bagdad, included in his gift to Charlemagne a unicorn's horn and a griffon's claw. These could be seen with the royal treasures at Rheims until the sixteenth century. It seems quite possible that the unicorn's horn had belonged to *Elasmotherium*. The

griffon's claw might have been the horn of another prehistoric rhinoceros found in Siberia, *Rhinoceros tichinorus* Fischer; for the Yukagirs in north-eastern Siberia – and they were not the only ones to have ideas of this sort – thought the horns of this animal were the claws of gigantic birds which their ancestors had had to fight for the possession of the tribe's hunting grounds.

There have been many other fascinating suggestions about the origin of the unicorn legend. A part is certainly played by the narwhal, another Arctic mammal, and one which is not extinct. The narwhal is of the whale family and has a long straight tusk. The tusks reached Europe, particularly Denmark, from Greenland and perhaps northern Scandinavia, and were quite definitely sold as unicorn horn. But this was long after the earliest records of the unicorn, which go back to the fifth century B.C. So the narwhal tusk can only have confirmed an existing legend; and there is more than a suspicion of sharp practice in the manner of its confirmation. One would imagine that an extinct creature had an advantage over an existing one in this matter. For there can – or there could then – have been no exact knowledge of what it really looked like, and the imagination could run riot. But the narwhal, though found only in remote places, was hauled out of the water and examined by someone, and the truth about its tusk not belonging to a horse-like creature would, one might suppose, get about; in fact, as Odell Shepard points out in his highly stimulating and vastly learned book *The Lore of the Unicorn*, it did; but the remarkable thing is that it made practically no difference.

But we have digressed. Let us return to the mammoth. The reason why quite a lot is known about him is due in considerable measure to the trouble taken by the Russian Academy of Sciences in following up the reports that came in from distant corners of northern Siberia. It was not easy to do this because there was inevitably a long delay between the discovery of the mammoth and the arrival on the spot of someone qualified to investigate. A native might find something unusual while on a long hunting trip. He would tell his friends when he got back,

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and word would eventually reach some Russian official in the district – generally the policeman – who would report to the capital. Several months would have gone by in this way before the Academy got to hear of it. The Academy would now hurriedly organize an expedition, but the speed of travel in Siberia was such that even after the appearance of the railway it might easily have been four months before the expedition reached its destination. In the year or so therefore that commonly elapsed before any reliable study of the specimen was made, all sorts of things could and did happen. The tusks would have been removed as a matter of course, because they were worth money. If the specimen was really well preserved, with plenty of flesh on it, this would probably have been eaten, either by dogs, wild animals, or the natives themselves. The meat might be tens of thousands of years old, but it had been refrigerated when freshly killed and was quite edible when thawed out. The Explorers Club of New York followed north Siberian tradition when it provided the guests at one of its recent dinners with a dish of Alaskan mammoth meat.

So it was not always easy to collect information about the mammoth, despite the relative abundance of material to work on. Over twenty corpses had been studied up to the time of the Revolution, but by no means all of these were very rewarding to investigate in view of depredations of the sort just mentioned. The best example recovered up to this time was one found in 1900 on the river Berezovka, which runs into the Kolyma. This specimen was dug up in 1901 by a party from the Academy of Sciences. It was remarkably well preserved because it was almost completely enclosed in a block of underground ice. The animal must have fallen down a crevasse in what was originally a sheet of ice lying over the ground, but which had by the time the mammoth arrived already been covered with a layer of earth. Thanks to this, a good deal of flesh remained – in fact it was the smell of rotting flesh which caused the corpse to be discovered – and this included the tongue, the stomach together with some thirty pounds of undigested greenery, and some coagulated blood. But much of the flesh was not there,

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and this was probably due to carnivorous animals. By both working at the site and travelling back in the autumn and winter, the party were able to get all the fleshy parts to St Petersburg without their thawing out. Here they were mounted in the museum of the Academy, where the heat brought out the smell to such an extent that the Empress, who came to see the marvel soon after, could not stay anywhere near it. Later the flesh was preserved in spirits. Study of this specimen was very fruitful, of course, but it answered only some of the questions zoologists were asking. A report of a good mammoth find will therefore still cause excitement in scientific circles.

Such a report was received in the autumn of 1948. The new find was in the north-west part of Taymyr. Photographs of the site were sent to Moscow, and these showed that one tusk had been removed (this was sent to Moscow too), while the other, the skull and, as far as could be judged, the rest of the body, remained in place. It was thought there was a good chance that even the internal organs might be preserved. A committee was set up to organize an expedition to the spot the next summer. Academician Ye. N. Pavlovskiy, a distinguished biologist and director of the Academy's Zoological Institute, was chairman of the committee.

The immediate vicinity of the find, which was on a river bank, was subject to periodical flooding, and it was not clear what would be the best time in the season to do the necessary digging. For this reason a reconnaissance party was sent ahead. It was led by Professor L. A. Portenko, a zoologist who had often been to the Arctic, and consisted of Professor B. A. Tikhomirov, a botanist, A. I. Popov, a geologist and permafrost expert, Ye. P. Shusherina, a soil scientist, five laboratory assistants, and five labourers.

By the end of May 1949 most of the party had assembled on the north coast of Taymyr, and in mid-June the party reached the site, which was some way inland on a tributary of the river Nizhnyaya Taymyra, in over-snow vehicles. The actual spot took some time to locate because the flag which acted as marker had fallen down. The digging was slow work, too, on

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account of the closely-compacted snow which had to be removed. It took four days to re-excavate the pit dug the year before. The temperature in the pit was always a little below freezing point, so that cutting into the undisturbed gravel in which the remains lay was very strenuous; on the other hand, the firmness of the ground permitted digging round the bones more accurately than might otherwise have been the case. Quite large fragments of ligament, with tissue and hair, were found, though they were much decayed. The fore-part of the animal, as far as the small of the back, was laid bare. It now became clear that the state of preservation was not as good as had been hoped; in particular, no internal organs remained.

At this time, with the job half done, the weather got a good deal warmer. Ice in the pit started to melt, and, more dangerous, the river showed signs of rising. The spring flood of an ice-bound river is an awe-inspiring event. The water from melting snow swells the stream, cracking and sweeping away the ice, and the flood-wave passes down the river with the tremendous destructive force represented by hundreds of thousands of tons of moving ice. It was decided to remove the portions of the skeleton which had been exposed and to fill in the pit. The decision was wise, for before long the whole of the digging was under water, and work could not be started again until a month later. The bones with flesh on them were stored in an improvised ice storehouse.

It was found when the flood had subsided that conditions for digging were much worse than they had been. The pit was near enough to the river for it to fill with water unless it was constantly being baled out. Locating the remaining bones was therefore not easy. The hind quarters had much less flesh on them than the fore-part. A week's work saw the last piece removed from the waterlogged pit. In order to make sure that nothing was left, the ground surrounding the pit was also dug over. This brought to light a rib bone; but it was not, curiously enough, a mammoth rib. The people on the spot thought it belonged to one of the now extinct species of rhinoceros (though not *Elasmotherium*).

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The site was well marked, in case further investigations were found to be necessary; and the finds were packed up and taken by air to the coast. By the middle of October they had been flown to Leningrad. The reconnaissance party had been able to do the job by itself, without calling up the rest of the expedition, apart from the leader, the geologist V. A. Mininberg. This had been possible largely because the mammoth had turned out to be a skeleton with vestiges of flesh, and not a complete corpse, as had been rather optimistically hoped.

But, for all that, the remains were very well worth having. They constituted the most complete set of mammoth bones in any Russian museum, and among the best from the point of view of preservation. They were set up in the Museum of the Zoological Institute and are now on view there. The only missing bones are the breastbone, some ribs, and some caudal vertebrae.

In what way has the excavation of this particular skeleton added to knowledge? Not all the results are yet available; only the first reports on the expedition have come out. But it is clear that the opportunity was taken to investigate all sorts of things not directly related to the zoology of mammoths, though of course that was studied too. The investigators know that their conclusions are only tentative, but they put them forward in the hope that later events will provide confirmation.

For instance, some of the bones, which were lying in the gravel of the river bank, were coated with a quite different peaty soil which closely resembled that of a terrace higher up the bank. This seemed to show that the corpse had been in the peaty soil and had slipped down into the gravel, probably when the river bank had been undermined and had subsided. The actual position of the skeleton also fitted in with this theory. Now the peaty soil was stratified in layers and had a number of plant remains in it; one layer contained chiefly cotton grass and green mosses, and these same traces were found in the soil round the mammoth. Thus the presence of the mammoth can be used to give a date to the plants, and to help build up a picture of the flora of northern Siberia at that time. In

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lower layers various tree remains were found: in particular the dwarf birch – *Betula exilis* – and willow, neither of which today grow as far north as this point. Comparison between the flora of the mammoth period and of the present in the same place is also full of interest, and for that reason a large collection of existing plants was made. It was the first collection of its kind, for all previous investigators of mammoths had paid no particular attention to the present surroundings of the corpse.

It is also suggested that the mammoth died at the period when the particular terrace of the river bank on which he had originally lain was being formed. The argument here is that he may have died when standing at the edge of the river, which is quite often the case with elephants today: the older idea that most mammoths died because they got stuck in some way is thought not to apply in this case. The temperature of the water in a pool near the river would have been low enough for enough of the time to preserve bits of flesh until they were covered over and permanently frozen. The flesh that had disappeared however would have disintegrated in this first stage, before permanent freezing.

Most of the mammoths that have been found with flesh on them were discovered in alluvial deposits, near rivers or lakes. It is fair to assume that all had spent some time in water, possibly even before they died. The preservation of any flesh at all may be due to this immersion. Certainly other inhabitants of the region at that time, animals which do not care much for standing in the water like reindeer, horses, or musk oxen, have never been found in anything like the same state of preservation.

This leads the investigators of the Taymyr mammoth to suppose that there must be a particular type of alluvial deposit which is most favourable to preserving mammoths, and this they term the 'mammoth layer'. They noted its geological features, and found that it was widespread in Taymyr.

The climate of northern Siberia at the time this mammoth died is thought to have been about the same as now, or perhaps rather warmer. Remains were found of a number of

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plants – the birch and willow among them – which prefer a warmer climate to the present one, and the mammoth lived either during the warmer period or just after it. This was in any case after the last Ice Age, and most of the evidence about mammoths in Siberia shows that they lived at the end of and after the Ice Ages. The average annual temperature in the warmer period was 4° to 7° F. higher than it is now; and the limit of vegetation was probably about 150–200 miles further to the north than now. This warmer climate however probably had very little effect on the regime of the permanently frozen soil, so that it would not have affected the preservation of the remains.

As far as the mammoth itself goes, the general opinion has been that it was a migratory beast, going up to the far north only in summer, in search of pasture. The evidence for this is that practically all Arctic mammals are migratory, and that the difference in temperature between summer and winter – which has always been considerable – would mean that food would be very hard to find in the winter. The expedition agreed with all this, and produced some more evidence which at least does not contradict the supposition: the hair found in 1949 had every appearance of being a summer coat. It was a good deal shorter than that of the shaggy beast in the cave-men's drawings, and this fits in with the suggestion that the mammoths were only down south in the winter. They probably moved in herds, as elephants do today. The party found in the vicinity a number of odd bones which belonged, they calculate, to eight other mammoths. One of these was a very young calf, which shows that the females gave birth to their young while on the northern migration.

More exact study of the skeleton leads the experts to the conclusion that this mammoth is the same species as the Berezovka specimen found in 1901, known as *Elephas primigenius beresovkius* Hay 1922. It was a fully grown male. The anatomists are at pains to point out that the curvature of the tusks (they are curved to such an extent that the tips point inwards) does not mean that they were useless to the animal; on the con-

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trary, it means that they were especially useful in scraping away the snow to look for pasture, because the side of the tusk is much better for this than the tip would have been. A good many mammoths in museums have the tusks mounted the wrong way round, because the museum experts were over-keen to show the tips in a position to be useful to their owner.

So the study of the mammoth continues. Reports are coming in all the time. A great number of mammoth remains were found in 1952, closely grouped in a 'mammoth cemetery' on a terrace of the river Berelekh, a tributary of the Indigirka. The bones were found to belong to both the small species (*Elephas primigenius minor*) and the big (*E. p. sibiricus*). Between 1952 and 1956 odd bones and tusks, but no complete corpses, were found in at least seven other widely separated places, from the Urals to Bering Strait. An appeal was sent out by the Academy's Zoological Institute in 1956 that anyone finding a mammoth should telegraph at once to the Institute's Committee for Mammoth Study (the delay in getting an expedition to the spot was still causing difficulty). There remain plenty of unanswered questions, and we may confidently assume that Siberia will continue to provide the answers. Without doubt there must be hundreds, if not thousands, of well-preserved mammoths still awaiting resurrection.

Conclusion

In the other chapters I have told the story of particular expeditions that have gone out in the last few years. They give an idea of the sort of things that go on in the Soviet Arctic – and probably a truthful one, too – but they were not specially chosen to make a well-balanced and representative picture. That would have been impossible, because the choice is strictly limited to whatever information has been published and permitted to come abroad.

Now, after giving the detail and the background by recounting incidents which have not been deliberately chosen, let me try to fill in some of the gaps in a less haphazard way. The question now is, what use has all this study, all this exploration and endeavour, been to the Soviet State? It has been useful in two distinct ways. There has been a gain to science: to the study of the natural phenomena of the polar regions, and in some cases investigations in the Arctic have led to discoveries of wider application. There has also been economic development: minerals have been found and exploited, timber felled, food produced.

Of the branches of science that the Arctic can tell us more about, there is one which has a very practical bearing on people living far away from the scene of study: the weather. The chain of Arctic weather stations is the key to the situation. There was only one regularly working station in the Russian Arctic before 1913. At the time of the Revolution there were six, mostly on the route to the Ob' and Yenisey from the west. It was between 1926 and 1939 that the network expanded quickest. Glavsevmorput needed the weather and ice information urgently, and stations were built along the coast and on the islands. By 1941 Glavsevmorput had seventy-seven stations. Today there are over 100.

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The stations are the main source of observations, because they make reports regularly and for long periods. But reports also came in from ships and aircraft, and from expeditions which happened to be working in remote areas. All this constituted the raw material both for fundamental study of the climate of the various regions and of the Arctic as a whole, and also for the forecasts which everyone was wanting.

Detailed climatic descriptions of different areas were worked up and published. One or two interesting points are made. For one thing, the coastal stations are not among the coldest places in the north. As mentioned earlier, the coldest place of all is Oymekon, which is inland in Siberia and actually south of the Arctic Circle. The *average* temperature of the coldest month of the year here is about -58° F.; while the lowest temperature ever recorded at a coastal station is only -60° F. Once again it is the moderating influence of the sea which brings this about. On the other hand, of course, Oymekon gets much hotter in summer than anywhere on the coast; so that the distinction of having the lowest average for the whole year falls to the polar station at Mys Chelyuskina, with $+5^{\circ}$ F.

The snowfall in the Arctic is very light – generally from four to eight inches in the whole winter. It is difficult to measure exactly, because there is often a strong wind blowing, so that some of the snow falling into the gauge has probably not fallen from the sky, but has just been blown along the ground from somewhere else.

Upper air observations have led to some conclusions about the thickness of the film of cold air which lies above the Arctic region; it is thickest in the eastern part of the Soviet Arctic in summer, while in the western part it is thickest in winter. This is probably due to differences in the wind strength in the two areas. The Soviet meteorologists can justly claim recognition for their contribution towards the technique of making these observations. The apparatus used is a radio-sonde. This is a very small and light radio set which is carried up into the air by a balloon, and as it goes it automatically transmits messages giving the air temperature and pressure. Professor P. A.

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Molchanov was one of the pioneers of radio-sondes, and he did quite a lot of work in the Arctic.

None of these points about the climate is particularly unexpected; in fact, most of the Soviet work tends to confirm what was known already. But it is no less valuable for that. The important point is that these observations, made regularly, at widely separated points and for a considerable period, provide a solid and reliable basis on which to build whatever theories may fit. Taken together, they confirm the 'warming-up' hypothesis that we have mentioned from time to time; and they begin to provide some sort of explanation, because they show how there has been an influx of warm air into the Arctic. Of course this only pushes the argument one stage further: why has the warm air come in? But the answer to that will not come from study of polar-station records, but of the whole question of the circulation of the atmosphere. Here again however it is meteorologists with Arctic experience who are taking the lead – men like G. Ya. Vangengeym and B. L. Dzerdzeyevskiy.

The same information provided the basis for the forecasts. Just how accurate and useful they have been it is hard to say. We must assume that the Russians know as much (or as little) about weather forecasting as anyone else. But the quality also depends on whether there are enough stations to give a true picture of what is happening over the whole area. And this is now certainly the case.

Taken as a whole, the work the Soviet meteorologists have done in the Arctic has been good, and useful not only to their country, but to the world. The Soviet Union has long been a member of the international meteorological organizations, and most of its information therefore goes into the pool. One says 'most', because there is some reason to believe that not all the Soviet stations broadcast on the international wavelengths. However that may be, the world derives benefit. As far as meteorological theory is concerned, they have produced many competent men, but no great figures.

If you want to find out about ice and snow, the Arctic sounds

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just the place to do it. And of course the Russians have spent a lot of time on this. The particular sort of ice that interests them most is that which floats on the sea – sea-ice. This is what creates nine-tenths of the difficulties for ships in the Arctic. Find out about it – its movement, formation, decay, strength – and you may be able to forecast what it is going to do next. That is the vital point for the Russians; so most of their ice study has been directed towards that end. They have also thought about their glaciers and their sheets of inland ice, but not on the same scale; partly no doubt because they have not got very much of that sort of ice. Unlike the North American Arctic, there are only a few islands with glaciers on them.

Where sea-ice is concerned, the Russians have done more than anyone else, because they have had practical reasons for finding the answers. As with the weather, the first stage was to organize collection of observations. The weather stations could do this, of course, if they were on the coast (and most of them were). But much more than that was needed, particularly observations from the open sea. So all ships were enrolled in the scheme, and special flights were arranged. Soon almost all the information required came from the flights. They were organized so that all the shipping lanes were observed about every ten days during the navigation season, and charts of the state of the ice over the whole area were drawn up equally often. The sea to the north of the lanes was covered less frequently, but still several times in the season.

This was already extremely useful to the shipping organizers. If you know where the ice is now, that will help you in trying to avoid it for the next few days. But ice has a way of changing, like the weather (and partly, of course, because of the weather), very quickly. Here the crucial difference between weather and ice studies became clear. Meteorology may not be an exact science, as plenty of holiday-makers know to their cost, but all the same the workings of the weather are pretty thoroughly understood. Not so ice. There were only the haziest and vaguest ideas about the effect of wind and current and temperature on floating ice. So although the raw material for the forecast was

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there, the principles of making one had not yet been evolved – or at least, not satisfactorily. In 1938 serious attention was given to this. A dozen or more scientists devoted much of their time to it. The results by 1945 were promising.

Two kinds of ice forecast were developed. Long-term forecasts predict the state of the ice in very general terms several months ahead, and short-term forecasts cover in greater detail a period a few days ahead. Foretelling the future at long range generally involves a good deal of guesswork – enlightened, perhaps, but none the less guesswork – and ice forecasting was no exception. There was of course the temptation to believe in cycles: that every fifth year is particularly bad, or whatever it might be. This line led nowhere. But some more hopeful lines were discovered. People may sneer at the idea: if we cannot foretell the weather three months ahead, how can we possibly know about ice? But the weather is only one factor. The ice is much affected by the temperature and movements of the seawater, and that varies at a much slower rate. So, by looking about for this sort of relationship, various correlations were found between temperatures, for instance, at a certain time and place, and the amount of ice at another place two or three months later.

Short-term forecasts had a more solid basis. If you know roughly what the wind and temperature are likely to do over the next few days, it is far easier to work out what the ice is likely to do. Armed with the charts showing the state of the ice at the present (or a day or two ago), and the weather forecast, teams of forecasters started in 1939 issuing five-day and ten-day forecasts. These were a great help, and soon became an indispensable part of the service provided for ships.

The Russians are without doubt a long way ahead of everyone else in this matter of ice forecasting. Other people have been working at it; particularly the Finns, who have evolved an efficient system for the Baltic, but they have a very specialized form of the problem. In a sense, of course, everyone has a specialized form of the problem, since there are plenty of local factors which make forecasting different for each place. But,

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as far as Arctic sea-ice goes, the Russians know more about the principles than the rest of us, as well as being much further advanced in the practice of forecasting for their own northern offshore waters. But we know very little of the system they actually use. There is plenty of literature available up to about 1941, and in it all sorts of hypotheses are put forward and expounded. But the really interesting information – what principles have been found the soundest, and how these are applied in practice – has been withheld.

Another sphere in which the Russians lead the world is the study of permanently frozen soil. This is a highly important branch of science, because unless you know something about it you cannot build anything – a house, a road, or a railway – in the Arctic. The permanently frozen zone covers a huge area of the Soviet Union – almost half the whole country. All but a small part of the Arctic is included in it. The subsoil in this zone never thaws. The layer on the surface, a yard or so thick, melts in the summer; but below it extends a wide belt – often hundreds of yards thick – of permanently frozen soil. This soil contains moisture, but in the form of ice. It seems more like rock than soil. But once the ice melts, the rock-like hardness disappears, and may well give place to mud; and anything resting on the surface founders. Furthermore, melting of the subsoil is not the only cause of difficulty. When the thawed top layer freezes again in the autumn, the moisture in it expands on becoming ice, and in doing so causes swellings and mounds to appear on the surface. In certain conditions mounds of this sort can be quite big – ten feet or so high, and seventy or eighty feet across. So this type of movement can do just as much damage as subsidence of the foundations.

And it is precisely the act of resting something on the surface which makes the subsoil thaw. For instance, the foundations of a house will conduct the heat in the rooms down into the ground. So when something is to be built in the permafrost zone, special precautions have to be taken. There are two possible approaches: either to try to leave the permafrost undisturbed by insulating the building from the soil; or deliberately

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to thaw out the permafrost, and calculate the stresses for the strength of the ground in its thawed state. Which approach is likely to be the best depends on the type of ground and the character of the permafrost at that place. In the far north, where the temperature of the ground is probably well below freezing point, it is best to leave the permafrost undisturbed; there have been many experiments and much paper has been covered in the attempt to find the most efficient way of putting the principle into practice. The Russians have thought about this for longer than anyone else, because historically Russia was the only nation which tried seriously to colonize and inhabit the permafrost zone; and they have far more experience (often bought dear, no doubt) on the practical side. They have built roads, railways, and heavy buildings in the far north, and they all seem now to withstand the destructive tendencies of permafrost.

They have succeeded largely because they organized a series of research institutes and experimental stations. They started doing this in 1930, and one of the first jobs was to collect and sort out the experience, of which there was plenty, gathered by the pioneers. On this basis experiments were made. Some at least of the results have been published and are quite accessible.

It is obvious that a country trying to pioneer a shipping route in little-known waters will do some oceanography. The word implies all-round study of the seas. The aspect with the most direct practical application is hydrographic survey, or chart-making. Most countries, the Soviet Union among them, set up specialized agencies to do this part of the work. Systematic survey of the Northern Sea Route area has been proceeding for many years. But since the war the resulting charts have not been available to foreigners, so the progress of the survey can only be judged indirectly. Many ships use the routes each year, apparently without undue casualties; but on the other hand remarks which appeared in the Soviet press in 1956 revealed that some important areas on the shipping routes were still uncharted. One may perhaps deduce that the survey still has some way to go – and it is, of course, a very great task – but that

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existing coverage is adequate to permit ships to circulate in reasonable safety.

The other aspect of oceanography – the characteristics and movements of water-masses, the living organisms they support – have been the province of various institutions. Work at first was confined to the fringing seas through which the shipping lanes passed. It has since been extended northwards, as we know. And this is where the most exciting and important results are to be expected. Almost everything that is known about the circulation of water in the Arctic Ocean – the last remaining basin of the world ocean to receive detailed study – was discovered by Russian work. The drifting stations and airborne parties have accumulated vast numbers of observations which fill many shelves in the Arctic Institute in Leningrad and keep a sizeable staff of oceanographers busy. All this, when the world is told the full story about it, will be one of the major Soviet contributions.

Much effort has been expended on geology. There have been no spectacular discoveries in geological theory, but a large amount of surveying has been done. The geologist R. L. Samoylovich was Director of the Arctic Institute for many years, up to 1937. Under his direction a large geological department grew up, and a great many expeditions were sent out. The time was ripe for energetic measures, because a prodigious area of the Soviet Arctic was quite unexplored geologically; and, more important, the Soviet Government was urgently concerned to discover within its own territory certain minerals which were conspicuously lacking. So there was every incentive to go out into the field and see what there was to be found.

The result was a tremendous spate of published papers, containing some first-class work and quite a lot that was third-rate. Undoubtedly some of the discoveries owed rather too much to the enthusiasm of those who made them. A large number of minerals were reported, with immense reserves, but this is a long way from implying that they could all be mined. Some of them are, of course, and they do indeed fill very important gaps

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in the Soviet economy; tin and nickel, for instance. More of this side of the question will be heard later.

But in 1937 Samoylovich was dramatically declared to be an 'enemy of the people'. His purge was also, to a large extent, the purge of the study of geology at the Arctic Institute. Part of Samoylovich's wrong-doing was his wasting time on geology, which had nothing to do with the immediate matter in hand – making the sea route work. This concerned only the Arctic Institute and the rest of the Glavsevmorput system; it did not mean that hunting for minerals was thought a waste of time, provided it was done by the right people. But the search was almost certainly slowed up, although the Government cannot have wanted that. With the passage of time, however, the interdiction became less severe, and in 1945 the Arctic Institute again had a geological department, which later became the independent Institute of the Geology of the Arctic. But in 1947 geological information was declared to be a State secret, so we know practically nothing about the progress of geological studies in the Arctic since the war.

So much, in broad outline, for science. There are other subjects not touched upon, such as ionospheric physics, terrestrial magnetism, and other branches of geophysics. There have been some Russian advances here, too – particularly in the theory of terrestrial magnetism. But most of the scientific effort was expended on practical problems of economics. Let us see what sort of results there were.

The mainstay of the economy of the Arctic is transport. Unless you can get about you cannot make use of whatever resources the Arctic may offer. The main effort has been to get the sea route along the north coast into working order, and something has been said about that. But other means of getting about have been developed too.

The rivers are the most important. In the Soviet Arctic they are many and large. Most flow northwards into the Arctic Ocean, but their tributaries reach out towards each other and begin to make an east-west waterway. The Ob', the Yenisey, and the Lena are among the dozen longest rivers in the world,

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and these three form the link with the populated centres of southern Siberia. The Trans-Siberian Railway crosses the upper reaches of the Ob' and Yenisey and comes very close to the headwaters of the Lena. In summer, boats and tugs travel along thousands of miles of navigable waterway in the heart of the virgin forest. Of course, the rivers are frozen and impassable for many months of the year; but some can still be used – as motor roads. Without its river system, the problem of getting about in northern Siberia would be all but insoluble.

Land transport is very limited. One would expect this, in such a vast area with such a small population. Two regions in the western part of the Soviet Arctic have a railway connexion with the rest of the country; Murmansk, the only port which is ice-free all the year round, is at the end of a line which was built in the First World War to secure Russia's communications with her allies; and the Pechora coalfield was linked to the main railway system in 1943, when the mines were rushed into production to help make good the loss of the Donbass. The Pechora line has recently been extended across the northern Urals to the mouth of the Ob'. There is another short piece of narrow-gauge line near the lower Yenisey; it brings minerals from the mines at Noril'sk to the port of Dudinka. All these lines are important, but they can affect the economy of only a very small proportion of the whole vast expanse of the Soviet Arctic. East of the Yenisey there is an almost total lack of railways north of the Trans-Siberian. Lines to Yakutsk and even to Anadyr in the Bering Strait region are sometimes mentioned (though never in Soviet publications); but there is no evidence that they really exist, and the Bering Strait line, at least, would have to overcome an impressive number of natural obstacles.

There are however several all-weather roads in this inaccessible north-eastern region. Yakutsk is linked to the Trans-Siberian in this way, and so are the mines of the Kolyma and Indigirka valleys to the port of Magadan.

Air transport has not been neglected, either. There are regular services to most of the centres of population. Important

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improvements were introduced during the war, when the Alaska-Siberia (Al-Sib) air route was pioneered and used for ferrying aircraft from America to the Red Air Force. The route runs from Bering Strait to Yakutsk, and thence southwards out of the Arctic. Its ground facilities were mostly supplied by lend-lease. From the point of view of economic development, however, the air can very seldom provide the whole answer. It will be useful, perhaps essential, for carrying labour and compact, valuable freight such as fur or gold; but it will not be much use for anything else.

A fairly efficient transport network has therefore been established and is being continually extended. There are still enormous gaps, but the existing network has permitted industrial development to take huge strides.

The first example which comes to mind is timber. The resources are vast. The great feature of northern Siberia is the *tayga*, or virgin coniferous forest. The forest stretches right across the country, from the Finnish border almost to the Pacific coast. In timber reserves the Soviet Union takes first place in the world, and Brazil, which is second, has less than half as much. The Soviet forests are not exclusively in the Arctic, of course, but a substantial part of them is. Tapping these resources is quite easy, because neither roads nor transport are needed to get the timber to the saw-mill; the river does the job. The greatest development of logging has been in the European north, between the White Sea and the Urals. The Pechora railway has helped here. Further east there is an important centre at Igarka on the lower Yenisey, and there are other centres on the lower Ob' and Lena. The quality of the wood is high. Igarka timber was, and is, exported across the Kara Sea to western Europe. In fact, the timber industry in the Asiatic part of the Soviet Arctic is very largely an export industry. Soviet domestic requirements can be met from less remote areas. It is an industry which could be expanded enormously, as far as timber supplies are concerned; the only physical limiting factor is port facilities.

After timber, minerals are the most promising product of the



19. Noril'sk in 1957, showing the football ground with some industrial plant in the background

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Arctic. There are many, as one would expect in such an enormous area, but not many have been more than superficially investigated and few are actually mined. Most deposits are in places that are difficult to reach, and operating costs would be extremely high. This is the general rule in the Arctic, so deposits are only likely to be worked at all if they are of extraordinary quality, or are vitally needed.

Coal is mined at many places in the Soviet Arctic, but with one important exception is used only for local needs (which includes bunkers for Arctic shipping). The exception is the Pechora coalfield. Once the railway had been finished, Pechora coal was sent to Leningrad and industrial centres in the northern part of European Russia. Output figures have only recently been published, and they show that production in 1956 was 15 million tons. The other Arctic coal-mines are very much smaller and are widely distributed: Noril'sk and the Pyasina area near the lower Yenisey; Nordvik on the Khatanga estuary; Ust'-Olenetskoye, Tiksi, Zhigansk, and Sangar-Khaya on or near the Lena; Zyryanka on the Kolyma; and Bukhta Ugol'naya in the Bering Strait region. The quality of the coal is generally rather low. But if these mines were not used, coal would have to be brought in from thousands of miles away; their geographical position is their whole importance.

Oil is needed locally in the same way as coal. Many attempts have been made to find oil, but up to the war worthwhile quantities had never been obtained. This had a bearing on the shipping situation: absence of local oil hindered the conversion of icebreakers and freighters to oil fuel, which would increase their range and carrying capacity and is generally admitted to be greatly preferable. There was one exception. On the fringe of the Arctic, at Ukhta in the Pechora region, oil had been struck (in fact it had been known about since the time of Peter the Great). Again not much is known about recent output, but in 1942 it is said that 1,200,000 tons were produced. Dr. Heinrich Hassmann, a German expert, estimates production in 1950 at 800,000 tons.

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So the situation up to the war was bad. *But recent events may have changed it.* The Pechora railway has been extended to the mouth of the Ob'. This means that Ukhta oil can be brought very easily to the Ob' estuary, where river ships can refuel. Another consideration is the fact that a refugee Soviet oil geologist named L. P. Smirnov claims that Ust'-Port on the Yenisey, Nordvik, and Kamchatka – all areas investigated before the war – may be producing up to 10 million barrels a year now. This claim is very hard to believe, even though Smirnov worked at Nordvik and should know the potentialities. But there may be a germ of truth in it.

Perhaps the most important mineral mined in the Soviet Arctic is gold. It was obtained in the Lena basin in the last century, mostly by a British firm, Lena Goldfields. Eastern Siberia almost certainly remains the leading gold-producing area. Since the early 1930's an organization called Da'lstroy has been getting gold in the remote upper Kolyma area, and thanks to the use of forced labour on an enormous and ruthless scale, has undoubtedly produced a great deal. Output, as usual, is secret. American estimates of annual production for the whole country just before the war are between 140 and 160 metric tons; this puts the Soviet Union well behind South Africa, the world's leading producer, and about level with Canada. Probably not less than two-thirds of this came from the Arctic. It was used to buy foreign currency, mostly United States dollars.

The story of Soviet gold is interesting. In the early years after the Revolution orthodox Communists were saying that the only use for gold would be in building monuments for the people. But a little later they saw that it might be useful after all to play the capitalists' game. The pendulum swung right over, and that was when Dal'sstroy was started. Now, after the war, it has been rumoured that production has dropped to the region of fifty to sixty metric tons a year. This may be so, because the American prohibition on exports to the Soviet Union makes the purchase of dollars less necessary.

The Murmansk railway has permitted the development of a large mining centre about 100 miles south of Murmansk, in the

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Kirovsk area. At Monchegorsk there are large nickel reserves which have been worked since 1938. An even richer deposit is mined near by at Nikel', in what was from 1920 until 1944 the Finnish territory of Petsamo. A subsidiary of the Canadian Mond Nickel Company used to work it. These two Arctic deposits, together with a third at Noril'sk were thought to produce about 8,000 tons a year in 1947 – over half the total Soviet production. This is a case where the energetic use of Arctic resources has made the Soviet Union self-sufficient.

Noril'sk deserves a special mention, for recently released population figures show that it had 92,000 inhabitants in the spring of 1956. This astonishing growth from nothing in little more than twenty-five years shows the importance of the mining operations, but the production details have not been released. Besides the nickel and coal mentioned, cobalt, copper, and platinum are also mined.

At Kirovsk large and rich deposits of apatite are found. Apatite is the mineral from which phosphate fertilizers are obtained, and this deposit is the largest in the world. So Kirovsk has become one of the great centres in that industry. Also in the vicinity are deposits of iron, titanium, molybdenum, copper, and other minerals, and these are mined, but on a lesser scale.

The Soviet Union was critically short of tin until very recently. She is probably self-supporting now, and this is due in quite large measure to exploitation of Arctic deposits. Production started during the war at four places in the Yakutskaya A.S.S.R. and one in the Kolyma area. Two of these deposits are known to be large, and later it seems that an even larger one was found in the Chaun region, near the north coast of Chukotka in north-eastern Siberia. But no details about how much tin may be produced have leaked out.

Fluor-spar production in the Soviet Union was considerably aided by the opening of a mine at Amderma, at the entrance to the Kara Sea, in 1935. The quality of the ore is higher than elsewhere in the country. But since reserves in more accessible regions are adequate, production (which is costly) has never been

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pushed very high: 15,000 tons in 1936 may not have been greatly exceeded. And it is now said that the mine has been shut down.

Shortage of salt in the Soviet Far East, where it was wanted for preserving fish, prompted an attempt to develop deposits in the Nordvik region. The salt here had been known about for a very long time. In fact, it was the 'salt domes' that made people suspect oil, because the Texas oilfield is associated with just the same salt structure. Between 1942 and 1944 some 38,000 tons were shipped out, but there are indications that this source was not developed further. Probably transport and operating costs were too high.

There are extensive and high quality reserves of graphite in the region of the middle and lower Yenisey, at Noginsk, Fatyanikha, and Kureyka (which has achieved fame for quite another reason: it was the place of Stalin's exile just before the Revolution). But they are not easy to reach, and there are big reserves in other parts of the country, so there has never been more than sporadic mining.

If mining is to be efficient, electric power is needed. This problem has not been solved at by any means all the mines. In some places local fuel is used. If oil is available too, that will make a great difference. Hydro-electric power is used only for the Kirovsk-Monchegorsk mining area, where the scale of operations is big enough to warrant building a power station on the river Niva. The town of Murmansk, which is the largest settlement in the world north of the Arctic Circle with a population of 168,000 in 1956, also has its own hydro-electric station on the Tuloma.

A find of the greatest importance has been made during the last few years, and although production has not yet started, it should certainly be mentioned. This is the diamonds in Yakutskaya A.S.S.R. The general area of the finds is to the west of the middle and lower reaches of the Lena. Alluvial diamonds were discovered at various points from 1948 onwards, and in 1954 the first kimberlite pipe was found – the same rock formation which carries diamonds in South Africa. Further investi-

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gations have already made it clear that the deposits are well worth exploiting. The country is difficult, of course, there being no local labour, no power supply, and no transport network other than the rivers. But since the Soviet Union has hitherto been almost totally dependent on foreign diamonds, there can be no doubt that production will be pushed ahead with characteristic Soviet vigour.

While the mining in the Arctic is certainly the most useful to the country's economy of all the activities that go on there, fisheries have a particular importance. Good fishing grounds are not easy to reach from the comparatively land-locked Soviet territory, but full use is made of one of the nearest – the Barents Sea. A flourishing trawler fleet is based on Murmansk, and there has been intensive scientific study of the fishery over many years. Damage to the fleet and to shore installations during the war was made good by 1948, but no catch figures are available. Just before the war the Barents Sea was said to provide 20 per cent of the total catch of the country, and later it is stated that its fishery took second place in the Soviet Union – presumably the Far Eastern fishery was first. The Arctic seas further east, north of Siberia, have too much of an ice problem to allow much scope for fishing; but the lower reaches of the big rivers are full of sturgeon and species of white fish which are caught now and could probably be caught in much greater numbers if the industry was organized. There is a cannery on the lower Yenisey at Dudinka.

Seal and walrus have been hunted for centuries in the seas north of the Soviet Union. The White Sea was, and still is, the centre of the sealing industry, but it goes on in the Barents and Kara Seas as well. Walrus are mostly found further east, especially in the Laptev and Chukchi Seas. Fats and hide are the products. There is a flourishing Soviet whaling industry in the North Pacific. It has shore stations on the east coast of Kamchatka and in the Kurils, and a fleet based on Vladivostok; its annual catch has grown steadily since the war. Since whaling is subject to international control, the statistics are published (though not in the Soviet Union, where there has been until

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very recently a horror of figures unless expressed in nearly meaningless percentages). The catch in 1955 yielded about 13,700 tons of baleen and sperm oil – the biggest catch of any whaling concern operating in the North Pacific.

Agriculture in the Arctic is generally a matter of trying to reduce the expensive import of food to Arctic settlements. Self-sufficiency in food for these places – presumably the ultimate objective – is still far off, despite some remarkable successes in the face of very severe climatic difficulties. Collective farms, which grow vegetables both in the open and under glass, have been established outside some of the towns. One of the drawbacks is the need to have a large amount of fertilizer, which has to be brought in; obviously there comes a point when it is easier to bring in the food rather than the fertilizer, so this is a factor which has to be watched carefully.

There are two farm products which are sent out of the Arctic: pelts and reindeer meat. The fur industry – for two centuries the main industry of Siberia, and in fact the reason why the Russians overran it – is no longer dependent chiefly upon native hunters; fur-bearing animals are kept in captivity, often by nomads who have been persuaded or otherwise induced to settle. It is still a flourishing industry, and the annual fur auction at Leningrad is attended by buyers from all over the world.

The reindeer meat comes from the recently organized reindeer collective farms, but the quantity available for sending out of the Arctic must be small. There are over 2 million domestic reindeer in the Soviet north, but they are the principal and almost the sole means of subsistence of most of the natives. The feed and space could support many more than this, and the Government has been taking steps for some time to encourage the growth of the industry.

The Soviet Union, then, has contributed not a little to scientific knowledge, and has gained quite a lot economically. There remains another sphere – strategy. There can be no doubt that she has derived also a strategic advantage. But here, one need hardly say, information is totally lacking and guesswork

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the only recourse. The direct military advantage lies in the technique of living and working in the far north; in the ability to use the Northern Sea Route, even if only for a few months each year; and, due to these, in the possibility of transporting men and materials and of establishing bases wherever they may be required. There is also an indirect, but potentially very important advantage in being able to find and extract vital minerals which cannot be found elsewhere.

To decide how far these strategic considerations have given the Soviet Government the motive for the whole vast programme of research and development can only be done properly from inside the Kremlin. From our great distance away we can only say that this aspect is not likely to have escaped attention; that it has probably played an increasingly large part since 1945; but that there are other motives which could be adequate.

These are the positive benefits which the Russians derive from their interest in the Arctic. It is possible also to generalize a little on the way they go about their northern work.

It may be argued that in a Socialist State all essential initiative comes from the top. Once the decision is taken, at a high level, to develop the Arctic, the necessary funds and manpower are automatically diverted to this, and it is done. The whole of the effort described in this book may therefore be ascribed to that one decision, taken in, say, 1930, and since carried along as much by its own momentum as by conscious reaffirmation. This is all to a large extent true, at least in theory. The practice differs somewhat in detail, but not in general outline. It is not the natural aptitudes or inclinations of individuals or races which cause the policy to be made. But once the policy is settled, then of course what natural ability there is must be brought into use.

If we ask therefore how competent the Russians have shown themselves to be at this work, we must look in two places for the answer. What natural ability was ready to hand, and how successful has the State been in building on this?

Ready available was the long Russian experience of the

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north. This implied a certain technical knowledge, a handful of interested scientists, and a large number of people used to the cold. It was a help, but would have been quite inadequate by itself. Under the Soviet regime much was added.

A State-run enterprise, at least in the Soviet Union, tends to mushroom. Ancillary institutions are created and grow, among them specialized training centres catering for particular needs. This is far from being always a good thing, but one of the good results in this case has been that there are enough trained men for the jobs. This sufficiency is not to be wondered at. The country can afford to be lavish in its use of man-power, and does not have to depend wholly on volunteer labour. In fact, however, there is probably little direction of skilled labour (we may leave out of account the great slave-labour camps, which are not sources of skilled labour, and anyway are not a peculiarly Arctic phenomenon), because the State provides effective money incentives in the form of high rates of pay, good holidays, and good pensions. This has had the effect of building up a cadre of polar specialists who have spent many years in the Arctic; and this in turn creates a tradition and makes it easier to attract volunteers and maintain standards. Competence in general terms is not only undoubtedly present but is likely to increase.

Within this general competence there are, of course, unevennesses. The work is normally methodical and thorough. Inventiveness, in the scientific context, is certainly there, but largely in the outstanding few. These few have not increased in number as a result of the technical training programme. But that has greatly increased the number of able, but not out-of-the-ordinary, scientific workers; and it has also thrown into the pool a smaller group of clearly inferior people, whose work is third-rate and would be unlikely to be published at all in a Western country. On the scientific side, the Soviet worst is worse than ours, but their best is as good.

On the administrative side competence is more difficult to judge because there are no printed results to judge it by. But one may suppose that the traditional incompetence of Russian

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bureaucrats has not very greatly changed. Certainly what one knows of the administrative arrangements of Glavsevmorput does not lead one to think that it has ever been a model of efficiency. Two small examples may be typical of the whole. In winter the Russians have for long used frozen rivers in the Arctic as roads. This is recognized as being very useful. But the technique of doing the small amount of preparatory work necessary is only known and practised in the Lena basin, and not elsewhere. Again, it has been recognized for years that the unloading and loading of ships at Arctic ports has been taking too long. Yet in 1957 some ports still had virtually no facilities, and these operations still took place miles off shore in the open sea. Here are two instances where improvements are held up, not because the answer is still undiscovered, but because of administrative failure. Glavsevmorput is probably no better and no worse than the other great bureaucratic empires within the Soviet system. But bad organization does tend to produce an ability to improvise, and there is little doubt that Soviet polar workers in any sphere are so used to things failing to go as planned that they have a highly developed faculty for improvisation – a useful attribute in the Arctic. The story of the *Sedov* is a good illustration.

The over-riding impression with which we are left is of an interest in the Arctic exceeding that of any other nation, and competently served by a small army of trained enthusiasts (in 1956 Glavsevmorput employed 35,000 people). It is the preponderance in trained manpower which presents the most striking contrast with the West. Few of the things the Russians are known or thought to do in their Arctic are new or incomprehensible to specialists in the West; but they may have five hundred men able to do a particular job where the West has five. Their interest, supported by the trained specialists, is now being extended with apparent success to the Antarctic. In a world in which the importance of the polar regions cannot but increase, this is a major force to be reckoned with.

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